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THE NICARAGUA CANAL CO., according to latest accounts, has completed 8 miles of the 12-mile road leading to the San Juan River and stone quarries. The stone to be obtained here is to be used in building the Greytown breakwater, which will be 1,700 ft. long when completed, and of which 700 ft. have been built. The canal locks have all been located, and dredging in the harbor and on the section extending from Greytown to the lake is progressing in excellent shape. In the harbor there is now 17 ft. of water on the bar, and a steamship, the first in years, has passed over.

IMMIGRATION for 1890 compares with 1889 as follows:

	1890.	1889.
English, Welsh, and Scotch	67,255	77,439
Irish	53,312	60,375
German	96 482	95,935
Swedish, Danish, Swiss, etc	59,941	58,349
Italian	62,492	29,606
Austro-Hungarian	63,095	42,170
Polish	19,737	4,866
Russian	40,883	33,474
Dutch, French, and other	27,829	24,498
Total	491,026	426,712

The increase is entirely from the less desirable races of immigrants, which now constitute over 40% of the total, a fact which ought to lead to some provisions for judicious restriction of the privilege of immigration to those fit to enjoy it.

THE SUBURBAN RAPID TRANSIT RAILWAY is to be controlled hereafter by the Manhattan system of elevated roads. This suburban road extends from the termini of the 2d and 3d Ave. elevated railway, across the Harlem River to 175th St. and 3d Ave. It is an elevated structure that cost about $1,431,000. Rumor has it that under the new management express trains would be run from the upper terminus of the suburban to the Battery on the third track that it is expected will soon be completed on 3d Ave.

A COMPOUND LOCOMOTIVE is to be tried on the Manhattan Elevated Ry., of New York City. It will be a four-cylinder engine, on a system invented by Mr. R. C. WRIGHT, of Philadelphia, Pa., who is now superintending the alteration of one of the ordinary engines at the company's shops. The high pressure cylinders are outside the frames, and the piston rods connect directly with the crossheads and crank-pins in the usual manner; the low pressure cylinders are inside the frames and have the piston rods connected with the main crossheads by means of levers, so that while the pistons of each pair of cylinders are moving in opposite directions, they will simultaneously pull or push the cross-heads. The high-pressure cylinders are 9 × 16 ins., and the low-pressure cylinders 13 × 16 ins. The driving wheels are 42 ins. diameter. The receiver is situated in the smoke-box. No changes will be made in the engine except those necessary to adapt it to the compound system.

A RAILWAY CROSSING ACCIDENT occurred Feb. 2 at Brockton, Mass. A train of 2 cars on the electric railway was crossing the Old Colony R. R. tracks at Crescent St. when "the second car caught in the rails and the power could not stir it." A passenger train came along at the time, and before it could be signaled it struck between the two electric cars, throwing one on each side of the track. Five persons were seriously injured, 2 of them fatally. These grade crossings are constant sources of danger, and numerous collisions have occurred. As long as such crossings are allowed to exist they should be efficiently protected, and street cars should not be allowed to cross when trains are due.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the New York Central & Hudson River R. R., at Rochester, N. Y., Feb. 3. An express train collided with a switch engine which was running from the round-house onto the main track. The switch engine was struck sideways, and both engines and two cars were wrecked. One man was killed. A rear collision occurred at Chicago, Jan. 31, on the Chicago & Eastern Illinois R. R., between a suburban train and a freight train that was standing on the track but had not a flagman out. Two persons were killed and 4 injured. The wreck caught fire from overturned stoves.

BRIDGE ACCIDENTS are reported as follows: An iron suspension bridge across Black Creek, at Lexington, Miss., was destroyed by a storm Jan. 31. It was built in 1878 by the King Iron Bridge & Mfg. Co., of Cleveland, O. The false works of a 150 ft. span of the Savannah River bridge of the Georgia, Carolina & Northern R. R. at Elberton, Ga., gave way Jan. 31. The Ward's Ferry suspension bridge across the Tuolumne River, 12 miles from Sonora, Cal., was destroyed by fire Jan. 31. A derailed sleeping car on the Canadian Pacific Ry. went over a trestle near Schreiber, Ont., Feb 4.

A BREAK IN THE OHIO CANAL occurred at Chillicothe, O., Feb. 2. It extended about 100 ft.

THE HOUSATONIC DAM, which failed in the late storm, has been examined by Mr. B. H. HULL, State Engineer of dams for Connecticut. He reports that about 250 ft. of the dam, from crest to base, has been swept away, and about 230 ft. of the dam will have to be rebuilt. The cause of the break was the undermining of the stone under the timber apron. With favorable weather the damaged work can be repaired in about 3 weeks.

AN IRRIGATION CONVENTION was held at McCook, Neb., Jan. 28 and 29; another will be held at Sidney, Feb. 7; and a third, intended to embrace the State, will be held at Lincoln, Feb. 11. The aim of these conventions is to secure needed State irrigation laws; to discuss national aid and encouragement to irrigation, and other matters of a general character. The McCook convention passed resolutions favoring for Nebraska irrigation laws based on those of Colorado and Wyoming; also urging the Legislature to make an appropriation of $200,000 to aid in irrigation development, and asking the Legislature to memorialize Congress for an appropriation of $1,000,000 for the same purpose.

THE GROWTH OF POSTAL BUSINESS in the first century of its operation (which ended with 1889) is set forth in the last report of the Postmaster General, by the following comparative figures:

	No. post-offices.	Post routes, miles.	Revenue.
1789	100	2,000	$30,000
1835	10,000	113,000	3,000,000
1860	28,000	240,000	6,000,000+
1889	62,401	428,000	61,000,000+

The number of letters mailed has increased from a total of about 1,000 per day to a total of nearly 8,000 *per minute*, there being 1,440 minutes in a day, so that the number of letters mailed has increased about 1,152 times, during a period in which the population increased 15 to 16 times.

THE WATER SUPPLY COMPANIES OF WESTERN PENNSYLVANIA recently held a meeting in Pittsburg, at the request of the State Board of Health, to see what can be done toward furnishing a purer supply of water. About 20 companies were represented. S. HALSEY WILLIAMS, of the New Castle Water Co., presided, and W. H. HARLOW, Pittsburg, acted as secretary. A report will be prepared and submitted to the State Board of Health, and probably a permanent organization of these water companies will be formed.

A TUNNEL is proposed for crossing under the canal, from Duluth to Minnesota Point. Plans and estimates for the work have been submitted by Gen. WM. SOOY SMITH, of Chicago. The tunnel with two galleries for railways would cost $1,338,359, or with one gallery, $906,440. The material to be passed through is fine sand and coarse gravel, permeated by water, and pneumatic caissons or the freezing process, or both, would be required to execute the work, the latter plan decreasing the cost of the work to $1,140,339 and $881,697, as contrasted with the sums above given. The apparent purpose of the tunnel would be to connect to Duluth a now isolated suburb, and Gen. SMITH figures out in his report that the project would pay very handsomely in the tax revenue from property much enhanced in value.

A RAILWAY IN THE UNITED STATES OF COLOMBIA is to be built from Pabas to Medellin, forming an extension of an existing line. The whole length of the road will be about 120 miles, of which 30 miles from Puerto Berrio on the Magdalena river to Pabas have been built, and are in operation. It will be a single track line of 3 ft. gage. There are several bridges to be built, but no tunnels. The surveys have been made, and the route is said to be in a healthy district, the line rising to a height of 4,000 ft. above sea level. The existing line is known as the Antioquia Ry., and was built by Mr. F. J. CISNEROS, M. Am. Soc. C. E. The government of the Department of Antioquia is prepared to receive proposals for the construction of the extension, and is said to possess ample means to furnish to any responsible contractor either the amount contracted for per mile of road, or a guarantee upon the capital invested. Information may be obtained from Messrs. Camacho Roldán & Nephew, Cotton Exchange Building, New York City.

THE PITTSBURG-LAKE ERIE SHIP CANAL COMMISSION held its final meeting at Pittsburg Feb. 3. The estimated cost of this waterway is $25,000,000, and the project is now to be laid before the Legislature of Pennsylvania. Vigorous opposition is expected from the railway interests.

OCEAN TEMPERATURES were the subject of discussion at a late meeting of the Geographical Society in London. Dr. BUCHAN, who has been for years investigating the meteorological aspects of the *Challenger* expedition, reported upon this subject. In the expedition mentioned, hourly or two-hourly observations were taken of the atmosphere and surface temperatures; and other observations were made of sea temperatures at various depths. The result shows that the diurnal range of temperature at the surface of the open sea is a little less than 1° Fahr.; while the temperature of the air over the sea was about three times greater than that of the water surface, with greater diurnal variations. As to thunderstorms, it was found that on land the maximum number occurred at mid-afternoon, when the air temperature was highest. On the open sea 70% of these storms occurred when the temperature was lowest.

Prehistoric Architecture.

Within the last few years prehistoric but imposing ruins have been discovered in parts of the world until lately supposed to have been always peopled by the lowest in intelligence of the human race. The Zumbabye ruins in Mashona land, in Africa, are now being investigated in the interest of science, and an attempt is being made to trace out the origin of these peculiar towers within towers, built of carefully squared granite blocks. Tradition says that this Mashona is the ancient Land of Ophir, and that the builders of these odd architectural remains were subjects of the luxurious Queen of Sheba. Others again ascribe them to the world-roving Phœnicians, and find an affinity between these remains and Phœnician ruins along the Mediterranean.

Now Mr. H. B. STERNDALE, an Englishman who has passed his life among the Pacific islands, calls attention to the island of Lelé, in 9.8° south latitude, 160° east longitude. In this island of volcanic origin he finds a wilderness of "ruined castles," with walls 12½ ft. thick and 30 to 40 ft. high in some cases, and covering rectangles 200 × 100 ft. on the sides, with some even larger. Many of these buildings seem to have been erected on artificial islets, and are surrounded by stone-lined canals. Mr. STERNDALE puts forward the theory that the early Hindoos reached, not only Polynesia, but also Central America, and points out that the Polynesians use the word *meru* for paradise and *dewa* for spirit, in proof of his assertions.

Most interesting remains of an equally remarkable character are found on Easter Island, over 6,000 miles to the east of Lelé and toward the South American coast. This Easter Island is also of volcanic origin and is only 11 miles long by 4 miles wide. But upon it are found immense platforms of large cut stone, some 6 ft. long, fitted together without cement. They are generally built upon headlands and on the seaward slope; and the walls on the sea side thus made necessary are sometimes 30 ft. high and 200 ft. long. On the platforms are yet the remains of colossal stone images, ranging from 14 ft. to 37 ft. in height. Remains of stone buildings are also found, with walls 20 ft. high, 5 ft. thick and 100 ft. long, and built in courses of flat stone laid without cement. The present natives of the Sawaiori race have no traditions touching the origin of these mysterious ruins.

In our own country we have yet much to learn of the real history of the cliff dwellers and architectural works in New Mexico and Colorado. In his late exploration of the Grand Cañon of the Colorado, Mr. STANTON made new and most interesting discoveries of remains of this character that are not yet made public; but many articles found, including perfect mummies, have practically convinced Mr. STANTON that the original inhabitants and builders of these almost inaccessible homes belonged to a period much more remote than any yet fixed for them, and that the immediate predecessors of the "red man" of a century or two ago had themselves, cuckoo-like, simply occupied the works of an earlier race.

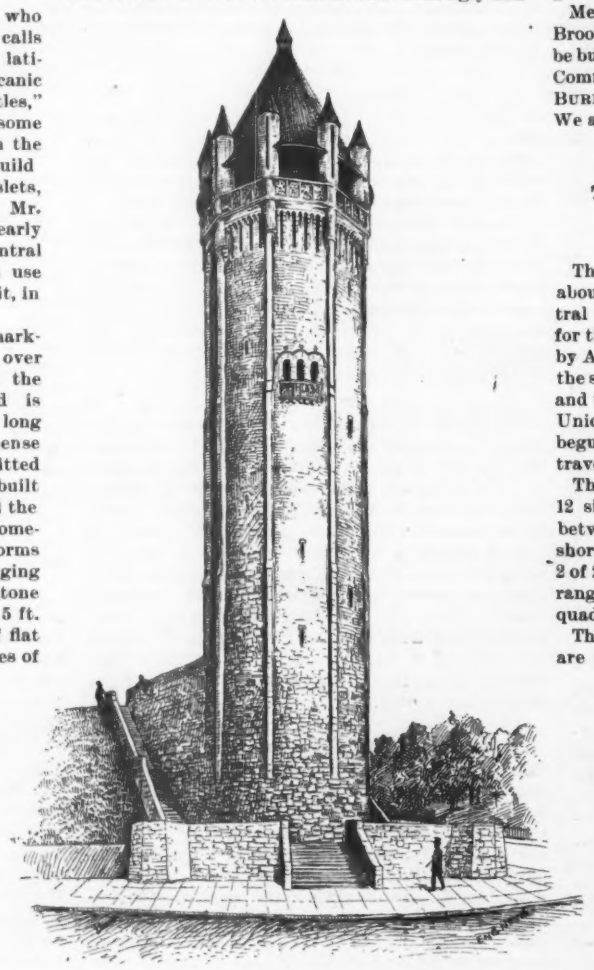
Phosphorus Photographs.

A novel method of contact printing has recently been described in *Photographische Archiven*, based on the fact that yellow phosphorus under the influence of light is converted into the red allotropic modification which is insoluble in carbon bisulphide. A solution of phosphorus in this solvent is first prepared and poured over a glass plate or lithographic stone, and allowed to dry in the dark. It is then exposed to the light under a negative for about half an hour, when a faint red image is produced. Any unchanged phosphorus is then washed off the stone or plate by a carbon bisulphide to fix the picture. Copper or silver images can be obtained from this by immersing the plate in a silver nitrate or copper sulphate solution, when the red phosphorus reduces the metallic salt. If paper moistened with either of the above salts be pressed on to the plate the metallic image appears on the paper. Further experiments are necessary in order to see whether the above reactions can be used for the reproduction of pictures on a commercial scale.—*Industries*.

The Proposed Water Tower at Brooklyn, N. Y.

The accompanying illustration shows a water tower which is to be built this spring in connection with the high-service of the Brooklyn water-works. It will be located on the embankment of the Mount Prospect high-service reservoir, at the Eastern Parkway and Underwood Avenue, near the Soldiers and Sailors Monument, at the entrance to Prospect Park. The tower will inclose a wrought-iron stand-pipe, 16×75 ft., with its bottom on a level with the top of the reservoir embankment, which is about 200 ft. above tide, high water in the reservoir being 198 ft. above tide, or 28 ft. above high water in the Ridgewood reservoir.

The tower is designed to inclose the stand-pipe and to render what would otherwise be an ugly and unsightly structure an artistic object, in keeping with the natural surroundings of the park and also with the Soldiers and Sailors Monument, near by. The tower springs from a platform about 15 ft. above the sidewalk. (In the illustration the first platform appears to be about 7 ft. from the ground, owing to a mistake in the levels furnished the architects.) This platform is reached by a broad flight of steps. From the platform, steps lead up each side of the tower to the top of the embankment. From the embankment a door opens into the tower. A spiral staircase occupies the space between the stand-pipe and the walls of the tower and leads to the platform at the top, from which there will be a fine view for many miles in all directions. The tower will be about 30 ft. in diameter and will have a total height of 176 ft. from the platform or first landing to the top of the lantern, the latter, as designed, being 338 ft. above tide.



Water Tower; Brooklyn, N. Y., Water-Works.

As shown by the illustration the tower is circular in plan, battering slightly in the first 45 ft. of its height from the platform to a point a few feet above the level of the top of the embankment. At the line of the cornice the plan changes to an octagon, but the roof is conical. Narrow windows light the stairways and relieve the surface of the tower Corbels support the slightly projecting balustrade and the roof is carried by turrets, which in turn are supported by buttresses carried down nearly to the ground and disappearing in the increasing size of the tower in the lower part. The balustrades are pierced to form a tracery of ornamental design. The roof is covered with fluted tiles and is surmounted with a lantern, in which it is proposed to place a large electric light, 160 ft. above the street.

The tower will be built entirely of red granite. Its body will be ashlar, with rock face, but the buttresses, turrets, corbels and window quoins will be hammer dressed.

Although the design for the tower has been accepted, the details have not yet been worked out, and consequently further figures cannot now be given.

Messrs. Thayer & Wallace, Jefferson Building, Brooklyn, are the architects for the tower. It will be built under the direction of Mr. JOHN P. ADAMS, Commissioner of City Works, and Mr. ROBERT VAN BUREN, Chief Engineer of the same department. We are indebted to the architects for the above data.

The Substructure of the Cairo Bridge.

[WITH INSET.]

The Cairo bridge was built across the Ohio River about 4 miles above its mouth by the Illinois Central Ry. The Union Bridge Co. had the contract for the entire bridge. The foundations were put in by Anderson & Barr, the masonry by L. M. Loss, the superstructure of the main spans by Baird Bros., and that of the approaches by the employees of the Union Bridge Co. Work on the foundations was begun in June, 1887 and the bridge was opened to travel in October, 1888.

The superstructure of the bridge proper consists of 12 single track steel spans of the following lengths between centers, commencing at the Kentucky shore: 1 span of 249 ft., 7 of 400 ft., 2 of 518⅛ ft. and 2 of 249 ft. The 249-ft. spans were deck, single quadrangular or Pratt and the others through double quadrangular or Whipple trusses.

The 10 piers supporting the 400 and 518⅛-ft. spans are in the river and have foundations sunk by means of pneumatic caissons 75 ft. below low water. They are numbered II. to XI. from the Kentucky shore.

The masonry starts 25 ft. below low water and at least 10 ft. below the river bed. The 249-ft. spans extend over the slopes and levees and rest on three smaller piers having pile foundations. The length of spans used gave a clear opening in the channel spans at low water of 500 ft., and a distance of 4,644.5 ft. between the centers of the end piers.

The Kentucky approach consists of 21 spans of 150 ft., 1 span of 106¼ ft., and 4,594 ft. of timber trestle. The Illinois approach contains 17 spans of 150 ft., 1 span of 106¼ ft., and 5,327 ft. of timber trestle.

All approach spans are single track, deck, steel, Pratt trusses, resting on piers composed of two steel cylinders filled with concrete and bearing on piles. Parts of both approaches are on 5° curves. The river bed is alluvium, with some loose rock at a depth of 175 ft., as shown by test borings.

The foundation work was recently described by Mr. E. H. CONNOR in a paper read before the Engineers' Club of St. Louis, which we reproduce in part below:

After a careful study of the conditions Messrs. MORISON, Chief Engineer, and CORTHELL, Associate Chief Engineer, decided to use, to secure foundations, caissons sunk by the plenum pneumatic process, which has been so successfully employed by the former on 7 large bridges over the Missouri River. The many logs lying buried deep in the sand and the possibility of striking steamboat wrecks excluded the use of the open caisson lowered by dredging, and the loose character of the bed and swift current during high water made the use of piles to support the piers of such an important structure hazardous.

In estimating the supporting power at Cairo reliance was placed on both the frictional resistance of the material passed through on the vertical walls of the caisson and the bearing on the sand at the base. The former was assumed at 400 lbs. per sq. ft. of surface exposed to friction, and the latter at 6,000 lbs. per sq. ft. due to the fatigue weight (*i. e.*, the actual weight less the weight of the displaced substances) on the foundation.

The piers were located from two base lines, 3,400 and 2,400 ft. long, and the caissons sighted in by transits after every sinkage of 8 to 10 ft. Pier II. was unavoidably sunk a foot too near the shore, but the others were within a few inches of the desired positions. The report continues:

The caissons of the three piers supporting the 518½-ft. spans were 30×70 ft. The remainder were 26×60 ft. All were 16 ft. high with a timber crib work the full size of the caisson built on in sections to a height of 50 ft. from the cutting edge. In the following description the numbers of braces and timbers given apply to the larger foundations, the smaller ones being of the same general design.

The outside walls of the caissons were vertical and built of one thickness of 12×12-in. timbers, ranging in length from 10 to 43 ft., so arranged as to break joints several feet. Two courses of oak plank 3 ins. thick were spiked to the outside by at least two spikes, 7×⅝ ins., to each square foot in each course. The first course was planed and put on at an angle of 45°; the outside planks were left rough and placed vertically.

The walls of the working chamber sloped at an angle of 45°, were built of 17×17-in. timbers and lined inside with one thickness of 3-in. pine plank. The timbers, by an ingenious joint, pass each other at the corners and extend into the outside walls. All timber used was yellow pine from Mississippi, except the outside planking. The working chamber and outside walls were fastened together by sixty 1¼ in. iron rods placed perpendicularly to the sloping timbers.

The courses of the outside and also of the inside walls were bound together by drift bolts 30 ins. long by ⅞ in. square, driven into ⅞-in. holes 3 ft. apart. The roof of the chamber, 8 ft. above the cutting edge, was built of 2 courses of 12×12 in. timbers, laid crosswise of the caisson, bolted together at their ends by 1-in. bolts, and supported by the sloping walls. The outside walls were braced at the bottom in the working chamber by 4 horizontal cross-timbers, and one longitudinal, 16×16 in.; 8 posts, 12×12 ins., extended from the cross braces to the roof. On each side of each cross brace was a 2-in. rod tightened by nuts on the outside. Above the roof the walls was braced by alternate courses of 3 longitudinal and 9 cross ties of 12×12-in. timbers dovetailed into the outside walls. At every intersection of these braces with the outside walls an iron rod, 2 ins. in diameter, passed vertically the entire height of the caisson and crib-work. Similar vertical 1¼-in. rods passed through the timbers where they rested on one another.

The crib work was built on in 3 sections of 12 ft. and 10 ft. each. At the top of each section the vertical rods had a washer and a turnbuckle to connect them with the next section of rod. The corners of the caissons were rounded off to a radius of 18 ins., and iron plates, ⅝ in. thick and 30 ins. wide, spiked on with 10½-in. spikes.

The walls of the working chamber were caulked and treated to 2 coats of white lead to prevent leakage of air and aid in illuminating the interior. The outside walls were caulked to the top of the caisson proper, 16 ft., or higher, to keep the space above the roof dry while putting in concrete below the surface of the water surrounding the caisson.

The shoe was made of iron plates ⅝-in. thick, and was 36 ins. deep. Twenty-four inches from the cutting edge was an iron shelf 24 ins. wide supported by brackets 2 ft. apart. From this shelf the timber walls started. The shoe was fastened to the timber by 2 rows of 10×⅛-in. spikes at the outside, and 10×⅝ in. lag screws, spaced 18 ins., passing through the shelf on the inside. The cutting edge was strengthened by a 1×5-in. iron band.

The main shafts, 3 ft., and the supply shaft 2 ft. in diameter, were built into the caisson and carried up through the concrete and masonry until the sinking was completed. To the inside of the main shaft an iron ladder was bolted, affording means of ascending from and descending into the chamber.

The air lock was made of ¼-in. iron plates and was placed in the crib work 8 ft. above the roof of the working chamber. It was 9 ft. long, 6 ft. wide, and 7 ft. high, with circular ends having a radius of 3 ft. The ends were separated from the center compartment which was itself divided into two spaces 3 ft. square. One of the latter had a circular hole leading upward and the other one downward. Each end was connected with each center room by an air-tight door, and formed a lock independent of the other.

One air pipe, 4 ins., 3 discharge pipes, 4 ins., and 1 water pipe, 5 ins. in diameter, were also carried up through the timber, concrete and masonry.

The caissons were built to a height of 16 ft. on the Illinois shore about three-fourths of a mile below the bridge site, this being the nearest available, suitable point, and towed to position by tugs. While being built the caissons were blocked up on six skids, or launching ways, of 12×12 in. timbers, which were nearly horizontal at the upper end and gradually increased in slope to about 3½ to 1.

The ways extended into the river to a depth of 7 ft. below the low water. The shore timbers were placed on blocks and held in position by planks driven each side of them. In the river they were held to 2 pile bents by drift bolts. A pile foundation for the entire length would have been better, since the ways were unstable and caused trouble at times. Some of the caissons were provided with false bottoms, thereby diminishing their draft. Their location and sinking is described as follows:

A clump of 3 piles was driven about 6 ft. from each corner of the permanent position of the caisson in the river, and by means of lines fastened to these piles the position of the caisson could be controlled while it floated. When, on account of the concrete filling, the caisson began to touch sand it was located in its proper place by the ropes and two transits, one at each end of the base line. As soon as it was well into the sand and the concrete filling several feet above the water, sinking was begun. As the foundation sank crib work was built on top, and concrete deposited in it at the same time, the timber being kept one section above the concrete to enable the vertical rods to be connected at the top of each section.

The sand in the working chamber was removed by the use of Monson sand pumps, and by blowing out with the air pressure. The action of the Monson is similar to that of the Eads sand pump but it is simpler in design and more efficient. In blowing out material a pile is heaped about the lower end of the hose extending into the caisson with a valve near its lower end. When this valve is opened the pressure of air forces the sand in large quantities and with great velocity through the pipe; or, the pipe may be extended below the level of the water in the bottom of the chamber, and the sand being stirred up, sand and water force out together. When the sand is blown out dry the loss of air is always considerable.

On the Kentucky side a layer of very hard clay from 1 to 3 ft. thick was encountered 60 ft. below low water. The greater part of this was worked up into balls and passed out through the wet blow-out pipe, and some of the hardest was "locked out."

This work was necessarily slow. Such material was not expected, and when struck a clay hoist could not be secured in time to be of advantage.

The maximum sinkage in 24 hours was 10.63 ft. at pier VIII. The usual progress in clean sand was 2 ft. to 4 ft. daily. The average daily progress for the time during which air pressure was kept on was 1.1 ft. at pier XI., and slightly over 2 ft. at pier II. The maximum depth below the water at which work was carried on was 94.2 ft. at pier IV. The time required by the workmen to pass through the lock was never over five minutes.

High water delayed the sinking in many instances, but caused the most trouble at Pier IX. When the cutting edge of that caisson was about 10 ft. in the sand, the river rose so rapidly that the contractors were unable to keep the concrete above the water, and work was necessarily suspended with the concrete about 6 ft. from the top of the crib work. The shafts were kept above the water, and a v-shaped timber guard built on the up-stream end of the caisson as a protection against drift. The river quickly scoured out a hole to the cutting edge at the up-stream end, and as there was no probability of finishing the concrete that season it was decided to sink the foundation 10 ft. more, or until the top of the caisson was only 12 ft. above low water, to secure it and to leave it till the following summer. About 1,000 cu. yds. of rip-rap and sand bags were deposited in the hole scoured out. Thus this foundation remained from January, 1888, until August of that year, out of sight but not out of mind.

The men for pressure work were arranged in gangs of from 8 to 14 men, depending upon the character of the material. Sinking was always continued night and day. No serious accident happened in connection with the caisson work.

When pier II. was within a few inches of the required depth it was necessary to blow off air from the working chamber to permit the caisson to sink, although all material had been removed from under the cutting edge. Therefore the frictional resistance on the sides could be obtained from the following data:

Penetration in sand, 86.42 ft.; immersion in water, 90.27 ft.; weight of caisson, 887 tons; weight of crib, 3,163 tons; weight of masonry, 2,800 tons; weight of sand and water, 1,806 tons; total weight, 8,656 tons; indicated air pressure, before sinking, 72.75 lbs.; calculated air pressure, before sinking, 39.117 lbs.; indicated air pressure lowered to 36 lbs.

From these the following are deduced:

Air pressure	42.75	39.117	36
Reaction due to air pressure	4,802	4,394	4,044
Net weight, tons	3,854	4,262	4,612
Surface in contact, square feet	12,910	12,910	12,910
Net weight per square foot exposed to frictional resistance, lbs.	597	660	715

In sealing the first caisson, at a depth of 77 ft., several of the men were temporarily paralyzed and 2 lost their lives. Afterward a different method of working was employed, with better success. One room on the pressure boat was fitted up for the men, with a stove and coffee pot, so that every one could have a cup of hot coffee on coming out of the caisson. A hot bath was also provided. While sealing one caisson a man carried in hot coffee a few minutes before the gang came out. No serious illness occurred while this was continued.

But the easiest, cheapest and most efficient prevention of caisson disease found was to cool the air before it entered the caisson. This was done by passing the compressed air through a number of 1-in. pipes coiled in a box into which water was pumped from the river and overflowed constantly through a pipe near the top of the cooler. The air passed from the receiver through a 4-in. pipe connected at the cooler by a T with 16 in. pipes 100 ft. long. The air was thus reduced in temperature from a 125° to 95°, where it entered the caisson.

The working hours of pressure men at divers depths were as follows:

Depth of cutting edge below surface.	No. of shifts of each gang per day.	No. of hours worked per shift.	No. of hours rest between shifts.
40 to 50 ft.	1	8	16
50 to 60 ft.	1	8	16
60 to 70 ft.	2	3	9
or	1	6	18
70 to 80 ft.	2	2	10
over 80 ft.	2	2	10
sealing	2	2	10
or	2	1½	10½

The original intention was to sink all piers to 75 ft. below low water, but this was slightly altered. Pier II. was sunk 66 ft. and pier III. 69 ft. below the river bed at those points, being several feet above the lowest stage of the river.

The concrete was mixed on a barge, anchored alongside of the caisson, hoisted up in buckets of 24 cu. ft. capacity and dumped into the pockets of the crib work. Two buckets and 50 men were employed in concreting. Six men were constantly spreading and ramming the concrete. About 2 ft. of material were put in a pocket each move of the scow.

The sealing of the working chamber, or the filling of it with concrete, was accomplished by means of a hopper bolted to the top of the supply shaft. The hopper had a door at the top and the shaft one at the bottom, both opening inward. These formed a lock operated by valves on the sides of the hopper, turned from the outside. Usually but one bucket of concrete was taken in at one time, as it was liable to stick in the bottom of the shaft if more was put in. All shafts were left in the masonry, except the main shaft above one section above the lock. The latter was enclosed in boxing through the concrete and masonry and easily removed. The lock was necessarily left buried in the concrete.

The shafts were left empty from the roof of the working chamber to 2 ft. below low water and the concrete started from the latter elevation on a wooden bulkhead, or the shafts were filled with sand to that point.

In the concrete from the roof to 2 ft above and for a depth of 1 ft. at the top of the crib work Portland cement, Alsen brand, was used. Between these layers Louisville cement was employed. In the filling of the working chamber Portland cement was used in the lower 18 ins. of concrete and in the 6-in layer of mortar rammed under the projecting shelf of the steel shoe, crossbeams and roof. The mortar was placed with unusual care and force, forming a smooth, solid-bearing surface.

The Portland cement concrete was made of cement, 1 part, sand 2, broken stone 3. The Louisville concrete consisted of cement 1 part, sand 2, broken stone 3½.

The cement used was carefully tested, some of the tests being summarized in ENGINEERING NEWS of Jan. 31. On completion of the work it was found that the volume of the Portland concrete was 9% less than the aggregate volume of the materials; the Louisville concrete was 32.5% less. The masonry was of oolitic limestone, of excellent quality. The up stream nose stone was granite in all courses between high and low water. The courses ranged in thickness from the bottom upward as follows: Five courses 3 ft., twenty-five 2½ ft., six 2¼ ft., 16 2 ft. belting 1¾ ft. and coping 2¼ ft.

The face stone was laid in mortar composed of Portland cement 1 part, sand 2, and the backing in mortar of Louisville cement 1 part, sand 2 parts. In freezing weather salt was added to the mortar to delay freezing and only Portland cement was then used. Tests made did not warrant the use of Louisville cement at such a temperature.

The face stones of the up-stream starting between high and low water were joined to the course below by dowels 1¼ × 12 ins., extending 6 ins. in each course. The face stones of each course for the three courses immediately beneath the coping were bound together by cramps of round iron, ⅞ × 20 ins., with claws sunk 3 ins. into the top beds.

The starling coping is placed at high water mark or 87½ ft. above the base of the masonry. All headers had a face length of 3 ft., or a trifle more, and a breadth of 4 to 6 ft.; the stretchers had a length as great as 8 ft. and a usual breadth of 3 ft.

The proportions of face stone and backing masonry in the piers was a surprise to many. The total and relative amounts for the different sizes of piers were as follows:

Pier No.	Cu. yds. Masonry in pier.	Per cent. Face stone.	Per cent. Backing.	Height of masonry.	Av. area of pier.
XII	447.0	83.0	17.0	142 ft.	287 sq. ft.
III	2712.7	58.3	41.7	221 "	605 "
X	2846.5	53.0	47.0	127 "	815 "

The approach spans rest on steel cylinders filled with concrete. Each pier consists of 2 cylinders, 8 ft. in dia-

meter, placed 18 ft. center to center and connected by a cross frame of rods and angles.

The cylinders are made of ¼-in. plates, spliced on the inside.

For the foundations of each cylinder a circular pit was dug 8 ft. deep, and 12 oak piles were driven in it. The pits were then filled with concrete to the proper elevation for the base of the steel cylinders, the cylinders placed in position, concrete rammed about them in the pit, forming an exterior ring 6 ins. thick, the cylinders filled with concrete and capped with a ¼-in. steel plate. The surface of the concrete was leveled off ¼ in. above the top of the cylindrical steel shell.

The upper two feet of concrete inside and that of the exterior ring was made of Portland cement 1 part, sand 1 part, into which stone was rammed after the mortar was in place. The remainder of the concrete was made up of Louisville cement with the usual proportions.

In the channel piers 331 M ft. of lumber, weighing 689.6 tons were used, 68.5 tons of iron, 77,345 cu. ft. of concrete weighing 5,607.5 tons, 102,508 cu. ft. of masonry weighing 7,688.1 tons, 1,027 tons of superstructure; the moving load amounted to 785.2 tons. Total weight on piers, 15,885.9 tons. But from this amount must be deducted 9,574.5 tons due to the weight of the displaced sand (78,000 cu. ft.), and water (22,756 cu. ft.) and the frictional resistance of the sand on the side of the caisson which is taken as 400 lbs. per sq. ft. This makes the actual fatigue weight 6,291.4 tons or 3 tons per sq. ft. of foundation.

The weights on the foundations of the rivers piers was due to 264.6 M ft. lumber weighing 551.3 tons, 62.2 tons of iron, 55,505 cu. ft. of concrete weighing 4,024.1 tons, 77,884 cu. ft. of masonry weighing 5,841.3 tons, 551 tons of superstructure, and 607.5 tons of moving load. From this amount must be subtracted the weight of the 78,000 cu. ft. of sand and 22,756 cu. ft. of water displaced, as well as the frictional resistance of the sand against the caisson, leaving an actual fatigue weight of 4,258 tons or 2.73 tons per sq. in.

The load on the concrete base of foundation pier 12 is made up of 905.4 tons, the weight of 12,072 cu. ft. of masonry, a superstructure load of 274.6 tons and a train load of 379.5 tons: making a total weight of 1,519.5 tons or 4.03 tons per sq. ft.

The "Standard" Steel Tie.

Steel railway ties have not yet been introduced to any extent in this country, but trials are in progress on several lines. Among the ties now under trial, one of the most novel in type, and one of the most promising, is the "Standard" tie, manufactured by the Standard Metal Tie & Construction Co., of New York.

This tie, as shown in Fig. 1, consists of a steel channel bar, laid with the open side uppermost, and having a block of creosoted, compressed wood under each rail. The channel is 7 ft. long, 3 ins. deep in side, and ¼-in. thick; for the ordinary ties it is 7 ins. wide, but where the track is laid with supported rail joints, joint ties 10 ins. wide are used. The ordinary ties weigh about 82 lbs., and cost $2.50 each, complete with bolts, wooden blocks, and all fastenings. For large orders this price can already be shaded, and it is evidently capable of considerable reduction. The ends are open, but in order to provide resistance to lateral movement in the ballast, a portion of the bottom is partially cut away and bent upwards. The tie is filled with ballast. The wooden blocks are 4⅛ × 6⅛ ins. square, and 2⅝ ins. thick; they are placed with the grain vertical to prevent cutting by the flange of the rail. At the rail seats, the sides of the channel are cut away for a depth of ½-in., so that the rails rest only on the wooden blocks. The rails are secured by Z-shaped clamps, as shown; the lower part of the clamp has two lugs which pass through holes in the bottom of the tie and bear on the under side, while the upper part has a flange which bears upon the flange of the rail. The clamps are held in place by a bolt passing through them and through the wooden block. Where supported joints are used the blocks and clamps are about 9½ ins. long, and the clamps are held together by two bolts. The rail fastening is certainly ingenious, and would seem to be among the best so far devised.

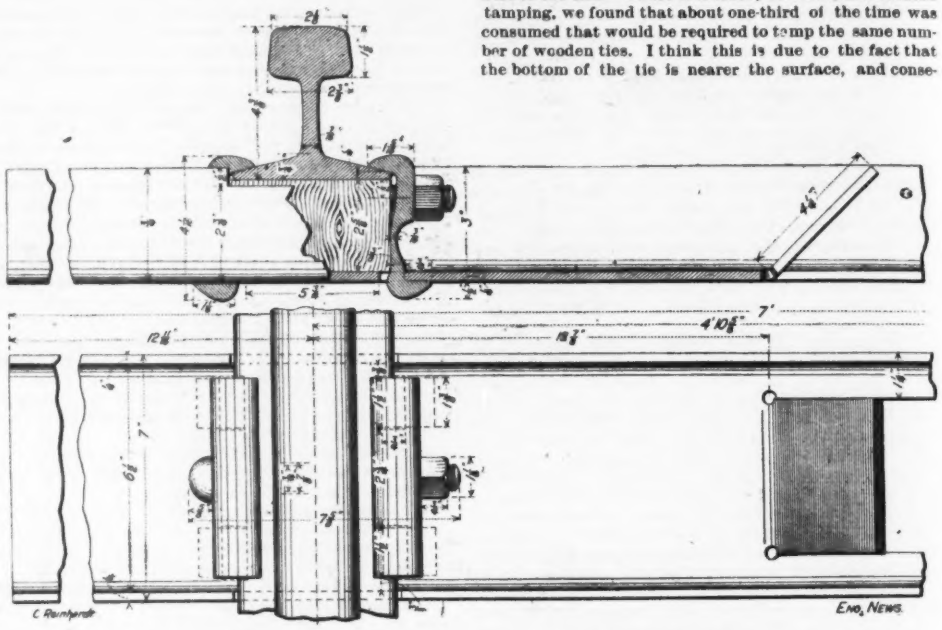


FIG. 1. SECTIONAL ELEVATION AND PLAN OF "STANDARD" STEEL TIE.

A later form of joint which has been brought out by the company is a suspended bridge joint, shown in Fig. 2. It consists of an inverted channel bar, the floor of which forms the seat for the rail, and is extended to bear on the wooden blocks of the shoulder ties. The rail is held by a pair of clamps gripping the flange of the rail and the bottom of the side of the bridge channel. Four bolts pass through the clamps and channel. In both these joints the rails are held by the flanges only, the company claiming that ordinary splice bars and bolts are not necessary, but such splice bars can be applied if desired, as has been done on the Chicago & Western Indiana R. R. In this case plain bars were used, as angle bars would interfere with the rail clamps.

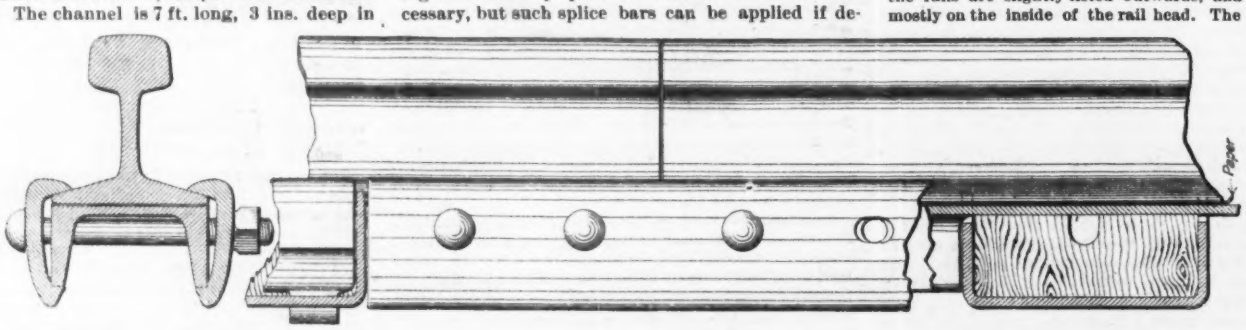


FIG. 2. CROSS-SECTION AND ELEVATION OF BRIDGE JOINT USED WITH THE "STANDARD" STEEL TIE.

The "Standard" ties were first tried on the Chicago & Western Indiana R. R., about 1,000 ft. of track having been laid with them in October, 1889. They are laid in light gravel ballast, and are spaced about 2 ft. apart, c. to c. The rails were laid with supported joints, and were spliced with plain splice bars, as above noted. In our issue of Feb. 8, 1890, we printed a letter from the roadmaster, Mr. J. W. CLARK, expressing a favorable opinion of the ties after they had been in use about three months under a traffic of about 80 trains per day. Mr. CLARK has written another letter, dated Jan. 22, 1891, which we give nearly in full, repeating his favorable opinion after an experience of nearly 15 months.

In regard to the present condition of the "Standard" metal ties that are in our southbound track south of 69th St., these ties have now been nearly 15 months in use, in which time over 37,500 trains have passed over them. The cost of maintaining them has been so small as to be hardly worth taking into consideration, for the reason that it consisted of redressing the shoulder of the west side of the tracks where teams along Wallace St. occasionally drive too close to the track and tear away a portion of the shoulder; but the cost of redressing is not chargeable to the ties. Where this track, however, necessitated tamping, we found that about one-third of the time was consumed that would be required to tamp the same number of wooden ties. I think this is due to the fact that the bottom of the tie is nearer the surface, and consequently requires no digging and less power to raise the track sufficiently to allow the tamping to be done.

The firmness with which the ends of the rails are held makes it impossible for them to move. The heads of the rails are perfectly even, and the usual "click, click" which the wheels make in passing over the ordinary joints on wooden ties has entirely disappeared, and the section when riding over it, seems like one continuous rail. I find also that the ends of the rails on the wooden ties are slightly flattened, while on the steel ties the rail ends are perfectly smooth and even, which indicates the absence of the wheel blow at the joint, so injurious to rail and rolling stock. With the "Standard" tie I find that the rail continues to stand perfectly upright, and the wear is directly on top of the rail head while with wooden ties the rails are slightly listed outwards, and the wear is mostly on the inside of the rail head. The sudden and sometimes severe climatic changes to which Chicago is subjected led me to expect that there would be considerable heaving of the tie when the ground became frozen and sinking when the ground thawed again, and that shimming would be so difficult as to render the tie objectionable on that account; but there has been no heaving or settling whatever. The track has remained in perfect line and surface, and no shimming has been required. The broad fastening of the "Standard" ties, which holds the rail so firmly on its foundation, permits less rail deflection than with the wooden ties and spike fastenings, which in my opinion accounts for the smoothness and uniform elasticity of the track. There has been no loosening of the blocks by swelling or shrinkage, and the blocks recently examined were found to be in as good condition as when first inserted. There have been

no loose bolts or nuts whatever; the rails are as firmly held now as when first laid.

On the morning of Jan. 15, a truck under a loaded grain car broke down while passing over this piece of track. One tie was bent, but so slightly as to be hardly noticeable. There is every indication that the ties will remain in good condition and service for many years. The saving in road gang wages, and the greater safety and smoothness in riding which they give, should merit their favorable consideration.

In July, 1890, 1,000 ties were laid near Ballston, N. Y., on the Delaware & Hudson Canal Co.'s road. This track is laid with 67 lb. rails; the suspended bridge joint above described is used, with four Harvey grip-thread bolts. The ties are all 7 ins. wide; they are spaced about 2 ft. 6 ins. apart and 2 ft. at the joints.

The ties are stamped from steel plates in a hydraulic press, specially designed for the purpose by Mr. HENRY AIKEN, which was erected in 1889 at the Carnegie Steel Works, Homestead, Pa. The bed plate weighs 14 tons, and upon it are upright frames forming the girders; these are connected at the top by a heavy cross-head or girder, which is secured to the bed plate by bolts. The moving head is operated by inverted hydraulic cylinders placed above the side frames. The upper side of this head is provided with cutters or dies for punching and slotting the plate, and on the lower side are the appliances for bending and shearing. The steel plate is first cut and punched by an up stroke of the head, it is then placed under the head and held in place at the down stroke, while 2 revolving bars bend up the sides to form the channel. An up-stroke of a plunger underneath the bed plate then forces knives through the bottom and presses up the loosened portions into the tie. The course of these operations is shown in Fig. 3.

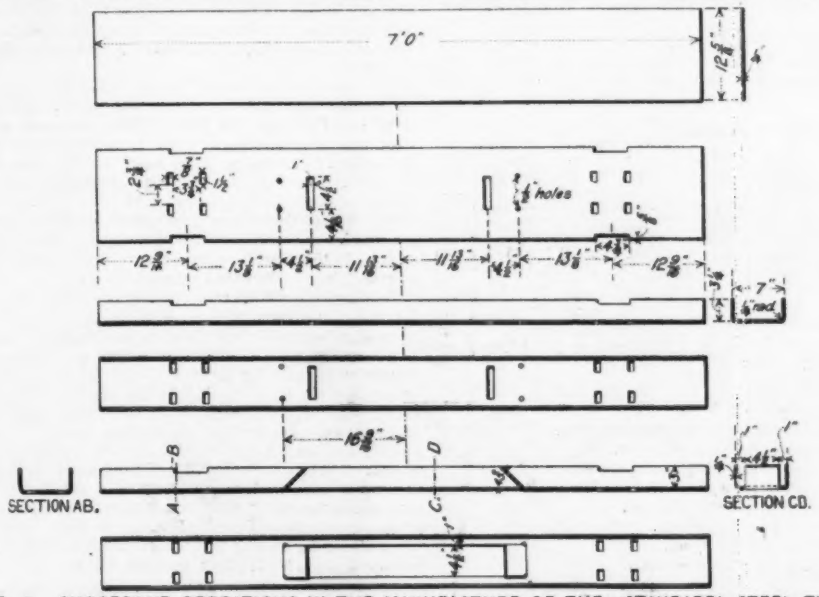


FIG. 3. SUCCESSIVE OPERATIONS IN THE MANUFACTURE OF THE "STANDARD" STEEL TIE.

References to the "Standard" tie will be found in ENGINEERING NEWS, June 29, 1889; Feb. 8 and April 5, 1890. Should it prove possible to make an effective metal tie weighing only 82 lbs. it will be contrary to the early Belgian and German experience, which indicated that 125 to 150 lbs. of metal per tie was necessary for durability; but that experience was on a quite different type of tie from the "Standard," and the latter would seem to have some elements which promise advantage.

Cement, Hydraulic Lime, Roman Cement, Portland Cement.*

The term cement was originally applied to all those substances which when mixed up with slaked lime produced a permanent hydraulic mortar. For this purpose many different materials were employed, principally, however, the various Puzzuolannas, Santorin earth and

*The above article is for the most part a translation made by Mr. ALDEN H. BROWN, of the University of Iowa, of an article on the subject by Prof. ENGLER in LADENBURG'S *Handworterbuch der Chemie*, although it has been changed and abbreviated so as to adapt it to the purposes of publication. The authorities cited in the original are generally omitted, since their works are current only in French or German. It is reprinted from *The Transit*, published by the Engineering Society of the University of Iowa.

vicinity of Mt. Vesuvius, where they have been used for submarine masonry since the time of the Romans. The same material occurs all along the southwestern slope of the Appenines, as far north as Rome and the departments of Herault and Ardiche. It forms a volcanic tufa of porous structure and variable hardness, but its most important characteristic from our point of view is that more than half its weight consists of silica, alumina, ferric oxide and other basic constituents of which the greater portion is soluble in concentrated sulphuric or hydrochloric acids, and in general the greater the amount of these soluble constituents the greater is the hydraulicity of the Puzzuolanna. The following analysis shows the composition of several varieties of this substance:

Nos. 1 and 2. Italian Puzzuolannas, dry (analysis by Elsner-Stengel and Elsner-Reinhardt).

No. 3. Italian Puzzuolanna (analysis by RIOST).

No. 4. From department of Herault (analysis by RIOST).

No. 5. From Auvergne (analysis by RIOST).

		1	2	3	4	5
Soluble Portion.	Silica	10.25	10.25	19.5	21.	28.2
	Alumina	9.01	2.56	9.7	10.7	2.
	Ferric oxide	4.76	4.56	6.3	6.8	21.8
	Calcium oxide	1.90	1.58	8.0	1.5	9.
	Magnesia	....	....	0.9	1.1	....
	Potassa	1.50	1.50	2.6	3.	1 2
	Soda	....	1.47			
	Water	....	....	10.2	12.4	4.1
Insoluble Portion.	Silica	48.90	49.56	32.7	35.5	25.
	Alumina	12.27	13.79	8.1	8.2	6.7
	Ferric oxide	....	....	....	....	....
	Calcium oxide	....	....	1.2	1.3	1.3
	Magnesia	....	....	....	....	....
	Potassa	2 87	....	....	....	....
	Soda	6.23	12.66	....	....	....

According to analysis by DEMARCHI and FODERA, Puzzuolannas from the vicinity of San Paolo have the following composition:

Silica	47.66
Alumina	14.33
Magnesia	3.86
Ferric oxide	10.33
Calcium oxide	7.66
Water	7.03
Alkalies and other substances	4.13
Sand	5.00

The same authorities also state that 15 per cent. to 40 per cent. of lime must be added to produce a good hydraulic mortar.

2. Trass, Duckstein or Tuffstein. This occurs on the eastern slope of the Eifel mountains, especially in the Brohl valley and the Nette valley, in the vicinity of Andermach and Neurried. To all appearances it is a product of volcanic eruption. In most places three distinct strata may be recognized. The lowest stratum from which the real Trass is obtained is about as hard as a file and has a vitreous fracture, it is porous and varies in color from yellowish gray to grayish blue. The second stratum is apparently the result of a later eruption; it is called Knuppen or Tauch; it forms a more friable and less porous deposit, and is mixed with pumice and shale. The third and most recent stratum is really a loose whitish gray volcanic ash, and is called the wild Trass.

The following analyses by different authorities show the composition of Trass:

		1	2	3	4
Soluble in Hydrochloric Acid.	Silica soluble in silica	....	....	2.18	2.57
	After treatment with hydrochloric acid	....	....	13.22	6.13
	Silica	11.50	5.15	0.12	0.18
	Alumina	17.70	16.02	5.95	5.18
	Feric oxide	11.77	3.33	4.66	3.55
	Manganese oxide	....	0.65	Traces	Traces
	Calcium oxide	3.15	1.25	2.98	2.57
	Magnesia	2.20	0.81	1.20	1.32
	Potassa	0.29	3.52	....	....
	Soda	2.43	2.47	....	....
	Water	7.65	12.65	....	....
Insoluble in Hydrochloric Acid.	Silica	37.43	49.93	43.54	59.85
	Alumina	1.25	2.26	7.46	8.45
	Ferric oxide	0.57	0.48	1.10	2.95
	Calcium oxide	2.25	....	1.71	1.78
	Magnesia	0.27	0.50	0.88	0.95
	Potassa	0.07	0.65	2.91	1.82
	Soda	1.11	1.27	0 35	0.34
Loss in heating (water)		....	....	5.66	2.59

In mixing mortar 2 vols. of powdered Trass are mixed with 1 vol. of quick lime.

3. The Santorin earth occurs on the Greek Islands Santorino, Theresia and Aspronisi; it is also a volcanic tufa, and is used in many marine structures on the shores of the Mediterranean Sea. This substance is distinguished from Puzzuolannas and Trass by its slight percentage of soluble constituents, so that it forms no jelly when treated with hydrochloric acid.

The mortar produced by mixing Santorin earth with lime has the peculiarity of only remaining hard under water. According to the investigations of Feichtinger this substance contains 20.03 per cent. of amorphous silicic acid soluble in dilute potassium hydrate, and it is to this that its hydraulicity is due. Feichtinger has made analysis of this substance dried at 100° (No. 1), and has discovered that it may be separated into three distinct portions, by a wash analysis, viz: One-fifth pumice (No. 2), three-fifths real Santorin earth (No. 3) and one-fifth Obsidian sand (No. 4).

		1	2	3	4
Soluble in Water	Calcium Sulphate	0.05	....	....	....
	Sodium Chloride	0.05	....	....	....
Soluble in Hydrochloric Acid	Silica	3.40	*	*	*
	Alumina	1.36	0.75	1.21	1.64
	Ferric oxide	1.41	0.28	0. 1	1.86
	Calcium oxide	0.40	0.40	0..1	0.3
	Magnesia	0.23	0.25	0.54	1.86

Traces.

		1	2	3	4
Insoluble in hydrochloric acid	Silica	66.37	72.84	71.44	63.07
	Alumina	12.36	11.51	8.56	14.03
	Ferric oxide	2.90	4.07	3.30	6.87
	Calcium oxide	2.58	2.15	1.80	3.15
	Magnesia	1.06	1.33	1.30	1.58
	Potassium oxide	2.83	1.28	1.86	1.87
	Sodium	4.22	2.65	3.74	3.86
Water		4.06	2.25	4.61	1.14
Salica soluble in dilute potassium hydrate			5.2	28.4	3.4

In making mortar five parts of this substance are mixed with two parts of lime slaked in sea water.

While it would appear from the investigations of BERTHIER, FUCHS, and others that the hydraulic properties of Puzzuolanna and Trass are due to the soluble silicates contained in them, where silica and alumina enter into combination with the added calcium hydrate; this process being accompanied by the absorption of water. On the other hand the Santorin earth owes this property to the free amorphous silica contained in it, which combines with the lime added to the mixture, when it is made up into mortar.

Besides these, several artificial products which contain soluble silicates, make good hydraulic limes when mixed with quick lime.

In Spain a mixture of one part of Ziegelmehl (dust from tile kilns) with one part of lime and two parts sand is used for the purpose. Raw copper slag and blast furnace slag have recently been utilized in this way, but the mortar made from them is but feebly hydraulic. HUSK has proposed to extract the soluble silicic acid from blast furnace slag by means of hydrochloric acid, to dry it and mix it with lime, thus making a hydraulic mortar.

Hydraulic Lime, Roman Cement, Portland Cement.

In accordance with the method adopted by the best authorities we will classify cements as hydraulic limes, Roman cements and Portland cements, understanding the first two classes as including all hydraulic substances

produced from natural mixtures of lime and clay by a burning process which has not been carried to the point of vitrification, and which still contain more or less free lime. Then we can distinguish hydraulic lime and Roman cement, the former being a burned siliceous limestone which falls to pieces on the application of water, while the latter must be mechnically pulverized before it can be used By Portland cement we mean cements produced from natural or artificial mixtures of lime and clay by a burning process which is carried to the point of vitrification.

The raw materials for the manufacture of cements consist of limestone, clay and their mixtures, and as these substances are exceedingly variable both in their physical characteristics and chemical composition their qualities must be ascertained by proper analysis, to determine the proper proportions of the various ingredients to use in the manufacture of cement. These analyses are made in the usual manner, and it will be best, perhaps, to omit a detailed description of them.

After these analyses have been made, the mixtures adopted should be tested by test burnings made on a small scale. For both the physical and chemical characteristics have an influence on the resulting product, so that a chemical analysis does not always indicate the best proportion of materials to use.

II. HYDRAULIC LIME AND ROMAN CEMENT.

These are usually made by burning siliceous limestones. SMEATON first discovered in 1793 that hydraulic limes leave a clayey residue when dissolved in acids. Soon afterwards in 1796 PARKER, an Englishman, secured a patent for the manufacture of hydraulic lime from nodular deposits containing chalk and clay, which occur in so-called London clay, a stratum of clay which overlies the chalk in the vicinity of London. The resulting product was called English or Roman cement. This same deposit occurs on the islands of Wight and Sheppey, on the coasts of Somerset and Yorkshire, and also on the opposite coast of France, near Boulogne, where a good cement was made from this material as early as 1802.

The composition of this substance shown by the following analysis

No. 1 by Davy.
No. 2 by Loftus.
No. 3 by Mulgrave.
No. 4. Boulogne cement by Drappi

	1	2	3	4
Calcium oxide	55	55.5	55	55
Alumina	9	5	7.5	7.5
Silica	22	25.5	21	23.9
Magnesia oxide	13	10.5	13.5	11.4
Iron oxide				

According to an analysis by SCHOFHAULT the Sheppey stone which has just been referred to, has the following composition.

	Soluble in acids.	Insoluble in acids.
Silica	....	16.51
Alumina	0.41	4.20
Ferric Oxide	....	1.03
Ferric carbonate	5.50	....
Manganic oxide	....	0.61
Manganous carbonate	1.55	...
Calcium carbonate	67.12	....
Magnesium carbonate	1.33	....
Magnesia	....	0.41
Potassium with traces of Sodium	....	0.88
	75.91	23.64

Deposits of a very similar character occur in many places and are utilized to a considerable extent in cement manufacture.

After some years the principle of hydraulic cements was recognized. Among the scientific investigations which led to the result, those made by FUCHS in 1830 should be given a leading position. This being the case, proper materials could readily be found, and the manufacture of cements advanced rapidly. Most siliceous limestones in which the calcium carbonate and clay are present in proper proportions, may be changed into hydraulic limes by a suitable burning process. Siliceous limestones containing from 22% to 25% of clay make the best hydraulic limes; they are burned quite easily. Those with less than 20% of clay are burned slowly and at a low temperature, while those containing more than 30% must be burned rapidly and at a high temperature. Accordingly, the burning is regulated principally by the amount of clay the stone contains, but the character of the siliceous sand which is always mixed with the clay must also be taken into consideration. Coarse sand enters into chemical combination more slowly than the fine dust sand or the aluminum silicate; it also hinders the combination of the calcium with the silicates, so that it is difficult to make a homogeneous cement from materials containing it. Besides, the physical characteristics of all the material have considerable influence. These can generally be determined by a wash analysis.

Usually the harder and firmer the limestone, the greater will be the density and hardness of the product. On account of the heaviness of the limes produced from it, marl is much used in the manufacture of hydraulic limes, and it will produce a better hydraulic lime the more nearly its composition approximates that just given. Good cements are often made by mixing together several materials, some of which contain much, and others little, clay.

The following tables by MICHAELIS show the composition of a number of hydraulic limes of different qualities, before and after burning:

I. LEAN HYDRAULIC LIMES.

(*a*) Before burning. Analyzed dry.

		1	2	3	4	5	6	7
Soluble in HCl.	Calcium carbonate	89*	88.00	87.81	86.87	86.19	82.5	82.82
	Magnesium carbonate	2.0	....	...	3.90	....	4.1	3.76
	Ferrous carbonate	....	1.89	0 42	....	0.85	....	...
	Manganous carbonate	....	....	....	....	0.66	....	....
Insoluble in HCl.	Ferric oxide.	9*	.90	9.37	4.23	....	....	1.66
	Alumina		3.29		....	7.08	13.4	....
	Silica		3.82		5.00	4.64	....	11.75

* Per cent.

(*b*) After burning.

Calcium	83.36	84.16	83.56	81.44	79.09	75.06	75.30
Magnesia	1.50	....	....	3.11	....	3.17	2.91
Alumina		5.56		....	11.60	21.77	....
Ferric oxide.		3.74		7.08	0.96	....	2.69
Manganic oxide	15.05	....	16.42	....	0.74	....	....
Silica		6.52		8.56	7.60	....	19.09
Sand and clay		....		....	....	...	....

1. Hydraulic lime for the Juras—Berthier.
2. Omberg's lime—Pasch.
3. Lime from Motala—Pasch.
4. Lime from Holkin Mountains in Flintshire—Muspratt.
5. Falhagen's lime—Pasch.
6. Lime from Nismes—Berthier.
7. Lime from Grenoble—Vicat.

II. MEDIUM HYDRAULIC LIMES.

(*a*) Before burning, analyzed dry.

		1	2	3	4	5	6
Soluble in HCl.	Calcium Carbonate	86.	76.5	72.9	76.82	63.1	84.48
	Magnesium "	1.5	3.0	9.3	2.86	12.3	.....
	Ferrous "	.....	3 0	....	3.21	2.4	.....
	Manganous "	.....	1.5	...	.....	...	.....
Insoluble in HCl.	Ferric oxide	.....	....	5.3	1.86	2.2	1.03
	Alumina	1.0	3.6	2.7	3 75	5.3	3 91
	Silica	17.0	11 6	7.4	11.03	11 2	10.57

(*b*) After burning.

	1	2	3	4	5	6	7	8
Calcium	70.51	68.19	65.73	68.56	56.01	74.83	72.00	71.13
Magnesia	1.12	2.63	7.25	2.09	9.28	....	1.67	1 87
Alumina	1.57	5.73	4.25	5.84	8 88	6.34	....	3 16
Ferric oxide	3.29	8.52	6.32	6.18	1.67	5.67	4.00	
Manganese oxide	....	1.64	....	....	....	....	....	....
Silica	26.77	18.47	11 95	17.18	17.75	17.14	20.68	16.83
Sand and clay	....	....	....	....	....	....	....	3.00

1. Marl from Senouches (Collet-Descotils).
2. Secondary from Metz—Berthier.
3. Lime from Horb in Wurtemburg—Knauss.
4. Cement stone from near Minden—Muspratt.
5. Lime from near Horb—Knauss.
6. Lime from Fecamp—Rivot.
7. Lime from Plasse—Vicat.
8. Lime from the Paviers—Vicat.

quite generally used for this purpose. Bituminous shales and siliceous shell limestones are used to some extent in Germany.

The burning of these substances is carried on in much the same way as that of Portland cements, which will be described further on, and the chemical reactions which take place are probably much the same except that they are not so complete on account of the lower temperature employed. They also contain an excess of free calcium oxide which in the case of hydraulic limes is sufficient to cause them to fall to pieces when moistened.

III. PORTLAND CEMENTS.

Portland cements, according to the definition which has just been given, are those produced by the burning of natural or artificial mixtures of lime and clay until they are vitrified. Portland cements take their name from the hydraulic cement manufactured in 1821 at Leeds, by Aspdin. This cement was made by burning a mixture of chalk and clay, and was called Portland cement from its resemblance to the Portland stone so much used for building in England. But, even before this, the manufacture of cements from artificial mixtures of the raw materials had been thoroughly investigated in France by Vicat and others. The last important step in the development of the principles of Portland cement manufacture was taken by Paswey in 1828, who found that an excellent cement could be produced by burning a mixture of blue clay from the Medway River with dry powdered chalk.

The raw material for the manufacture of Portland cements consists of limestone and clay; the latter generally contains the silicic acid; as yet flint and infusorial earths have been only experimentally used as a siliceous material.

By limestone we mean every natural or artificial calcium carbonate that is of sufficient purity. In practice it is usual to use the light porous materials rather than the hard limestones, since it is very difficult to grind them fine enough. Accordingly chalk, light marls and fresh water limestones are most frequently used. In certain kinds of marl the clay is of such quality that a good Portland cement can be produced by simply burning the substance until it is vitrified, no other material being added. In this class belongs the marl which occurs in inexhaustible deposits near Perlmoos, Tyrol.

The clay for Portland cement must possess certain special qualities; it should consist of a homogeneous mass of finely divided plastic materials; no foreign bodies should be perceptible with the naked eye; any crystalline substances which may be present should be finely divided and uniformly distributed through the whole mass; it should not feel gritty between the teeth and should work up to a smooth paste when mixed with water. We have already noticed that the amount of sand should be ascertained. The less the proportion of sand and the finer it is, the better is the clay for this purpose, since very fine sand affects the other materials in much the same way as powdered clay. Chemical analyses show that the value of clay for cement manufacture varies with the proportion of silicic acid in its aluminum silicate.

III. STRONG HYDRAULIC LIMES.

BEFORE BURNING.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Soluble in HCl.	Calcium carbonate	62.47	76.82	66.67	67.86	55.87	59.33	61.08	68.02	70.64	68.7	66 81	63.0	57.2	63.8	57.8	52.4	84.8	83.93
	Magnesium carbonate	1.35	2.81	1.50	5.62	0 60	0.88	1.08	1.60	1.02	2.3	...	4.0	3 6	1.5	5.7	7.0	....	.....
	Ferrous carbonate	5.85	3.21	6.55	3.30	.....	.....	.....	.....	.....	.....	3.49	....	6.6	11.6	...	....	....	.....
	Ferric oxide	....	.....	.....	.....	5.03	6.93	4.95	2.61	2.58	2.3	.....	....	..	....	6.3	11.6	....	.....
	Alumina	0.93	0.89	.....	.....	1.16	4.07	2.83	5.13	2.86	1.6	...	...	...	....	1.1	4.3	....	.....
Insoluble in HCl.	Alumina	7.72	2.86	5.01	4 18	2.60	1.63	0.80	1.04	3.08	3 80	29.54	2.7	25.2	5.7	2 4	2.5	0.6	0.65
	Ferric oxide		1 86	1 55	1.13	2.04	1.10	1.36	1.30	1.40	2.10				....	1.9	1.2	0.5	traces
	Calcium	0.12	0 12	....	0.15	0.70	.....	...	.....	.....	.....				....	.....	.....	....	.....
	Magnesia	0.30	0.05	.....	0.57	.....	.....	.....	.....	.....	.....				....	.....	.....	....	.....
	Potassium		.....	1.01	.....	0.35	0.28	0.35	0.24	0.55	0.7				.....	0.9	0.8	....	.....
	Sodium		.....		.....	0.50	0.46	0.32	0.62	0.82	0.3				....	0.2	0.2	....	.....
	Silica	20.93	1.03	16.96	15.57	29 19	20.14	24.05	12.70	15.92	17.80				14.	21 9	17.2	12.4	13.75
	Water, etc	...	.....	.....	.....	1.04	4.12	2.28	6.12	0.79	0.40	.....	6.0	7 4	3 4	1.8	2.8	1.7	1.77

AFTER BURNING.

	1 and 2.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Calcium	58.88	55 65	59.10	43.73	48.08	49.56	60.95	58.80	56.44	53.93	55.05	50.44	55.69	46 36	41.36	77.87	76.55
Magnesia	2.25	1.58	4.98	0.40	0.62	0.73	1.22	0 73	1.60	.....	2.90	2.71	1 12	3.93	4.73	....	.....
Alumina	7.24	7.47	6.47	5 14	8.35	5.20	9.87	8.83	7.92	.....			8.88	5.01	3.65	1.00	1.00
Ferric oxide	7.97	9.05	5.28	9.66	11.76	9 35	6.26	5.92	6.46	....			12.47	11 74	18.86	0.82	trace
Potassium	1.51	....	0.48	0.41	0.50	0.39	0.82	1.03	46.07	42.05	46.85	.....	1.28	1.13	.....	.....	
Sodium		.....	0.68	0.67	0.46	0.98	1.22	0.44					.....	0.29	0.28	.....	.....
Silica	23.66	25.27	24.12	39.93	29.50	34.68	20.32	23.67	26.12				21.85	31.36	24.41	20.33	22.39

1 and 2. Cement stones from near Minden—Muspratt.
3. Lime nodules from the London clay (Sheppey stone).
4. Limestones from near Ruderadorf.
5, 6, 7 and 8. Bavarian marls—Feichtinger.
9. Marl from Perlmoos, near Kufstein—Feichtinger.
10. Limestone from Yorkshire. Whitby cement—Knauss.
11. Motala limestone (best kind)—Pasch.
12. Limestone from Argenteuil—Vicat.
13. Limestone from Pouilly—Vicat.
14. Limestone from Vassy—Vicat.
15. Limestone from Essex. Harnich cement—Knauss.
16. Limestone from Kent. Sheppey cement—Knauss.
17. Limestone from Theil—Rivot.
18. Limestone from Theil—Rivot.

Marls, which are suited to the manufacture of hydraulic limes and Roman cements, are widely distributed and are

The following table by MICHAELIS contains analyses of a number of clays adapted to cement manufacture:

No. 1. Clay from Saxony—analysis by Michaelis.
No. 2. Clay from Verpommern—analysis by Michaelis.
No. 3. Clay from Upper Harz—analysis by Michaelis.
No. 4. Clay from Bradenburg—analysis by Michaelis.
No. 5. Clay from Medway River—Feichtinger.
No. 6. Clay from Medway River—Faraday.

	1	2	3	4	5	6
Silica	60.06	50.25	60.00	62.48	68.45	64.72
Alumina	17.79	23.12	22 22	20.00	11.64	24.27
Ferric oxide	7.08	8.53	8.99	7.33	14.80	7.64
Calcium oxide	9.92	.....	4 18	6.30	0.75	1.89
Magnesia	1.89	2 89	1.60	1.16		....
Potassium	2.50	1.87	1 49	1.74	1.30	....
Sodium	0.73	1.60	0.72	0.37	2.10	....
Gypsum	0.60	2.73	0 89	0.60	....	....

Concerning the ferric oxide which occurs in most clays in connection with the aluminum silicate, it is to be

noticed that a slight percentage of this substance is advantageous, but a larger amount has the opposite effect.

The raw materials should be mixed in such proportions as to insure a proper chemical composition for the resulting product. The chemical composition of a good cement should approximate the following formula; Al_2O_3 10 Si O_2 20 CaO, or as expressed in percentages:

Cacium oxide	58.06
Silica	25.72
Alumina	7.09
Ferric oxide	3.23

These figures will indicate the proportions to be used in mixing the raw materials, and in this connection it should be noticed that the proportions of lime and clay are much the same as in the case of hydraulic limes and Roman cements, that is if we reckon on one side calcium and the alkalies and on the other the silicic acid, alumina, iron oxide, manganese oxide and sulphuric acid, entirely disregarding the magnesia, which must simply be considered as replacing a portion of the calcium oxide.

PREPARATION OF THE RAW MATERIALS.

This has a great influence on the efficiency of the burning process, which follows, for it is only when the lime and clay are ground to the finest powder, and most intimately mixed together, that the burning produces that reaction among the constituents of the raw material, to which the hardening of the cement is due. There are three different methods for producing this result. Either by grinding the materials dry and mixing them in that condition (dry process), or in the case of friable marls and chalk, the mixture is made by stirring the materials up in a wash mill until they are so fine that they are readily held in mechanical suspension in the water. A stream of water flows constantly through this wash mill and carries the suspended particles to settling basins. Then there are the half wet processes

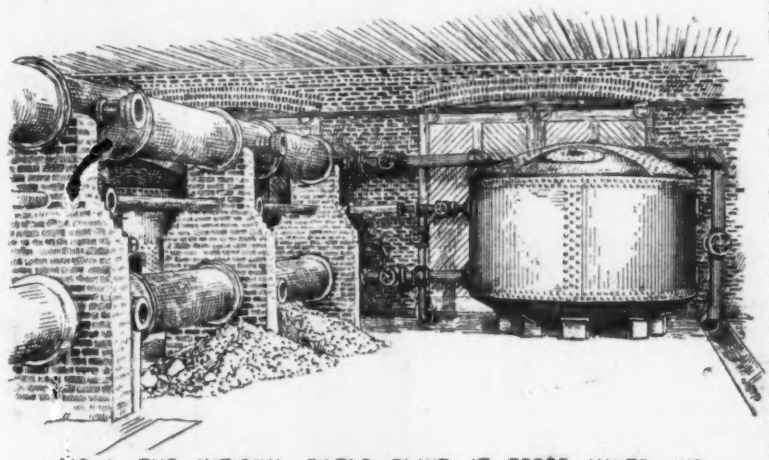


FIG. 1. THE NATIONAL FILTER PLANT AT TERRE HAUTE, IND.
View from photograph, showing inlet and outlet mains and wash pipe, with one filter connected.

in which one of the materials is made into a paste with water, the other having been properly ground.

In all these processes the materials are subjected to a second wet mixing, just before being made into lumps for burning. This is done in a pug mill or similar device.

The character of the grinding apparatus varies with the character of the raw materials; several forms of stone crushers and mills are used, but for very fine grinding stone burrs that are used in old fashioned flouring mills are the best.

Hard materials are usually dried before grinding, since this facilitates their reduction to powder.

Of the three processes mentioned the wet process is the oldest and is still the one most generally used, although it requires a much greater outlay than either of the others.

After the mixing process has been completed, the wet material is formed into lumps and thoroughly dried. This is usually done in ovens heated by the hot draft from the cement kilns.

(To be continued.)

The National Filter Plant at Terre Haute, Ind.

The filter plant which we illustrate herewith is notable as being one of the largest of the commercial filter plants as yet put in service, and also from a mechanical point of view because of the successful solution of a rather knotty point in the design of a large cylinder to sustain heavy internal pressure.

The plant consists of 12 filters, each 10 ft. in diameter, thus giving a total filtering area of 942½ sq. ft. The nominal capacity is 3,000,000 galls. per day. This indicates a rate of flow through the sand of about 2 2 galls. per sq. ft. per minute.

Fig. 1 shows a perspective view of one of the Terre Haute filters in place; Fig. 2 is a plan view of the filters with the connecting mains, and Fig. 3 shows a partial cross-section of the filter house, taken through one of the filters. The operation of the apparatus may be clearly seen by reference to Fig. 3. The filter is a water-tight steel cylinder, nearly filled with sand. Two 20-in. mains run the length of the building, the upper one bringing the unfiltered river water from the pumping station; the lower one taking away the clear filtered water

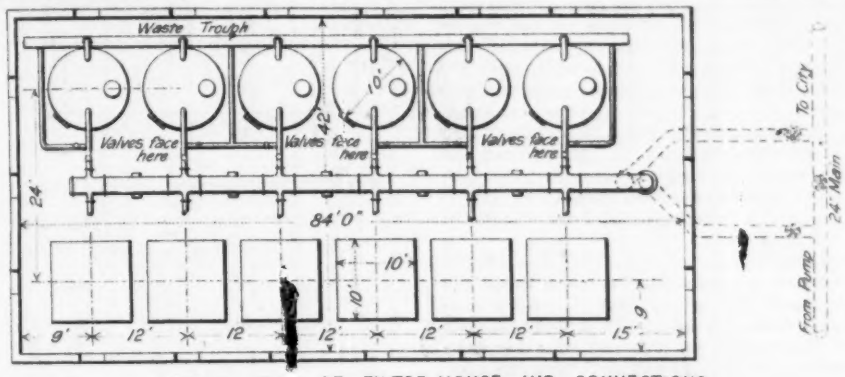


FIG. 2. PLAN OF FILTER-HOUSE AND CONNECTIONS.

to the city mains. Each filter is connected at the top by a 6-in. inlet pipe with the unfiltered water main, and at the bottom by an outlet pipe of similar size to the main carrying the filtered water. The particles of sediment are arrested by the sand, and the clear water is sent at the bottom. To prevent the sand from being washed into the outlet pipe, the latter is connected with a system of tubular strainers covering the whole bottom of the filter with orifices so fine as to prevent the entry of the sand.

The bottom of the filter case is filled with concrete up to the level of the strainer pipes. This holds the pipes in place and prevents any of the finer particles of sediment from working down and lodging below the bottom row of pipes.

As the flow of water continues, the upper layer of the sand becomes clogged by the collected sediment, and it becomes necessary to wash the filter. This is done by reversing the current through the sand. Valve *A* on the inlet and valve *B* on the outlet are closed. Valve *C* in the waste pipe is then opened and also valve *D* in the 4-in. wash pipe. This pipe connects with a system of perforated strainers distributed in a horizontal plane over the whole area of the filtering bed, and at a distance of about 6 ins. below the surface of the sand. The wash pipe takes water from the filtered water main near its exit from the building. This reverse current breaks up the surface layer of the bed, where most of the sediment has accumulated, and it is carried off by the flow through the waste pipe to the sewer. After washing the surface from 3 to 5 minutes, valve *D* is closed and valve *E* is opened. The wash water then passes through the strainers at the bottom of the bed, lifting the whole mass of sand and washing out the finer particles of sediment which have lodged in the lower portion of the bed. The washing from the lower portion of the bed requires from 5 to 7 minutes. The waste pipe is made with a sleeve on its lower end, by lifting which the character of the flow can be seen. As soon as the water flows clear, the washing is stopped, valves *C* and *E* are closed, and valves *A* and *B* are opened, and filtering goes on as before.

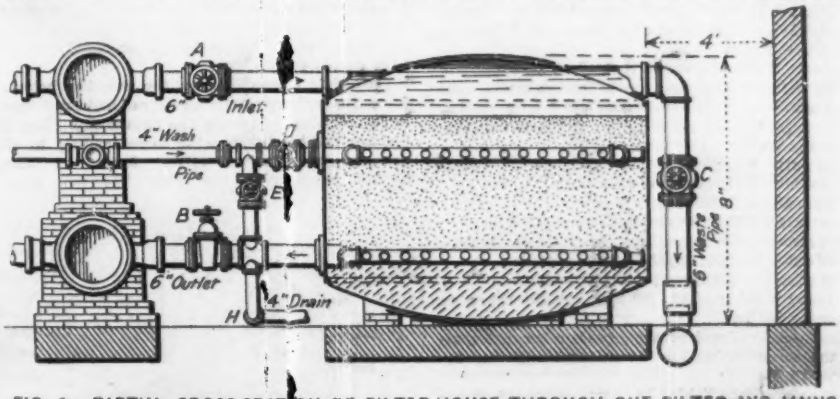


FIG. 3. PARTIAL CROSS-SECTION OF FILTER-HOUSE THROUGH ONE FILTER AND MAINS.

The loss of pressure in passing through the filters varies from 4 to 10 lbs., according to the length of time which has elapsed since the washing of the filters. In case of necessity the gate in the 24-in. main can be opened, and the flow will pass direct from the pumps to the city without entering the filters. Any filter can be cut off from the rest and drained of all water by closing valves *A*, *B*, *D* and *E* and opening valves *C* and *H*.

The filters are set in two rows in a plain brick building, 84 × 42 ft. The floors are of concrete, and a conduit at each side carries away the waste water used in washing the filters. The water supply is pumped from the Wabash River, and before passing through the filters carries a considerable amount of mud even at low stages. The following analysis of water after filtration was made by Prof. W. A. NOYES, of the Rose Polytechnic Institute:

Parts in 1,000,000.

Total solids	294
Chlorine	6.8
Nitrogen in form of nitrates	0.8
Free ammonia	0.002
Albuminoid ammonia	0.11
Oxygen consumed by organic matter	2.0
Nitrites	none

A small amount of alum, not more than one part in 70,000, varying according to the amount of sediment in the water, is added at the pumping station. This unites with the fine particles of clay in the water to form a gelatinous mass, which entangles the fine organic matter in the water and stops it from passing through the sand. It will be seen that no alum is shown in the analysis, it being carried off with the sediment which it precipitates.

Mr. L. L. WILLIAMSON, Superintendent of the Terre Haute Water-Works, writes us under date of Jan. 29, that the filters are giving satisfaction

From 2% to 5% of the water pumped is used for washing the filter beds, the amount varying, of course, according to the amount of sediment in the water.

A difficult feature in connection with the installation of this plant was the construction of a shell which would stand the heavy internal pressure required (200 lbs. per sq. in.) without leakage. As the filters are 10 ft. in diameter; the area of each head is 11,310 sq. ins., and the pressure against it at 200 lbs. per sq. in. equals 2,262,000 lbs., or 1,131 tons. This pressure has to be borne entirely by the flanges of the head, as no internal braces or stays are permissible. The construction may be seen by the perspective view. The cylinder and heads are made of best quality boiler steel, $\frac{1}{4}$ ins. thick. The joints in the heads are re-enforced by broad cover plates on both inside and outside, and some of the cases have withstood a test pressure as high as 208 lbs. without leakage.

In this connection it may be said that a filter 20 ft. in diameter was erected last summer by the National Water Purifying Co. for the Canton Manufacturing Co., of Canton, Mass., with a daily capacity of 1,000,000 galls. The test pressure in this case, however, was only 50 lbs., thus making the pressure upon the head the same as in the Terre Haute filters.

Irregular Wear of Locomotive Tires.

At meetings of the Western Railway Club, reported in ENGINEERING NEWS of April 26 and May 31, 1890, some discussion took place concerning the effect of excessive counterbalance in causing flat spots on the left main driver of four-wheeled connecting engines, the spot developing at the point where the tread touches the rail when the left pin is just passing the forward center. At the meeting of the club on Jan. 20 the following paper on the subject was read by Mr. J. N. BARR, Supt. of Motive Power of the Chicago, Milwaukee & St. Paul Ry. We have commented on the paper in our editorial columns:

The tendency of locomotive tires to wear irregularly, that is, to form flat places, is one of the most annoying and expensive of the minor trials to which a railroad master mechanic is subjected. This trouble is aggravated when roads pass through sandy districts. At first sight the most natural conclusion is that the tire varies in hardness, or resistance to abrasion, and this undoubtedly is the cause of a portion of the trouble, but from an extended series of observations the writer is compelled to conclude that a material portion of the trouble lies outside the tire itself. This conclusion has been arrived at from the following observations:

1. The tires of several locomotives, showing serious flat places have been slipped around on the center, then trued up and placed in service. The flat places in every case formed again at the same place relative to the center, but in a different place on the tire.

2. Observations made on a large number of tires running in a sandy district showed that the flat places grouped themselves with a close approach to uniformity, occupying nearly the same position with reference to the pins and counterbalance.

The above clearly indicates that there are cases of irregularity in the wear of tires due to the forces which are in action in operating the locomotive, and it is the purpose of this investigation to partially determine the nature, extent and influence of these forces.

For this purpose Engine 316 was taken, the dimensions bearing on the question being as follows:

Cylinders: diam. 16 ins.: length 24 ins.

Drivers: diam. 62 ins.; weight on drivers, 54,000 lbs.

Steam pressure: in boiler, 160 lbs.; in cylinders, 130 lbs.

Point of cut off: 6 ins.; speed, 40 miles per hour.

Weight of reciprocating parts, each side, 480 lbs.

Main rods: total weight, 269 lbs.; weight taken as reciprocating, 117 lbs.

The total weight of reciprocating parts was counterbalanced, the counterbalancing being equally divided between the wheels.

With the above data Table 1 has been computed, showing the forces in action at each 10° of a revolution, the zero point being taken as that point at which the right hand driving-wheel pin passes the forward center.

This table shows in the first column the position of the wheel by degrees. The second, third, fourth and fifth columns show the pressure of each wheel against the rail, with the engine moving at 40 miles per hour. The pressure of the two back wheels varies from 9,660 lbs. to 17,340 lbs., or 3,840 lbs. above and below the static load of 13,500 lbs. This variation is due entirely to the influence of the centrifugal force of the counterbalance. The pressure of the two forward wheels is subjected to precisely the same influence from the counterbalance, and in addition to this the angularity of the connecting rod effects a decided modification of the pressure on the rail.

The sixth column, headed "total," shows the sums of the pressures of the four wheels upon the rail. The total pressure varies from 67,712 lbs. to 45,935 lbs. a difference of ten tons. The sixth column is represented graphically in Diagram I.

The seventh column shows the pressure against the pin, normal to a line passing through the centers of pin and wheels, or the force at the pin tending to produce rotation. This column is represented graphically in Diagram II. The rotative force at the rail can readily be deduced from these figures.

The eighth column shows the relation between the forces producing pressure on the rail and the forces which have a tendency to cause the tires to slip. The figures are obtained by dividing the force tending to slip the drivers, or the rotative force at the rail by the pressure on the rail. We will call this ratio the coefficient of slip. It corresponds in form and relation to what is known as the coefficient of friction. If the value of the coefficient of slip is equal to the coefficient of friction, the wheels will be on the verge of slipping. Diagram III. is a graphical representation of these values.

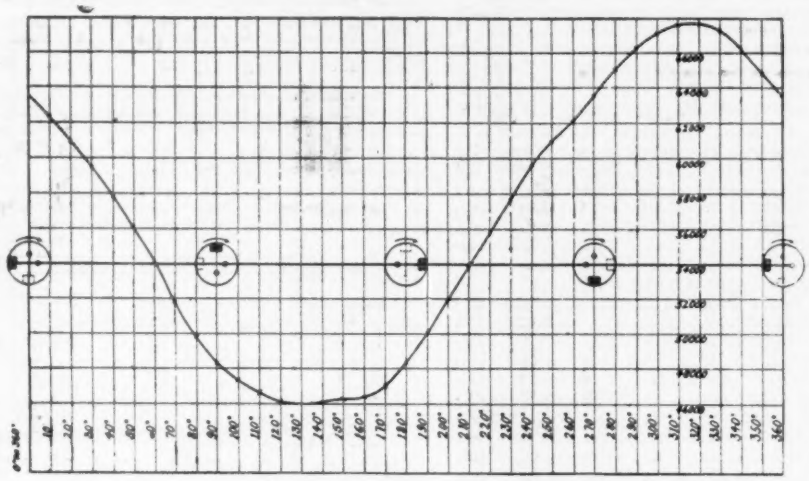


Diagram 1. Total Pressure of all Drivers on Rail through one Revolution.

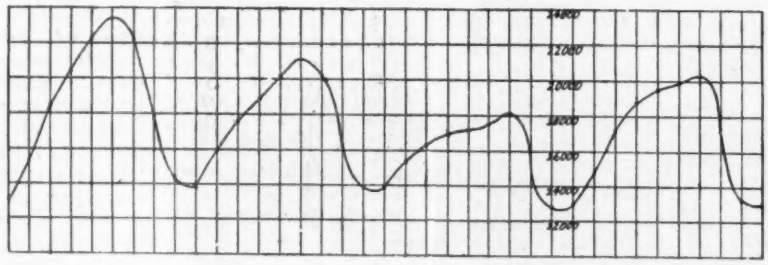


Diagram 2. Total Rotative Force acting against Crank Pins through one Revolution.

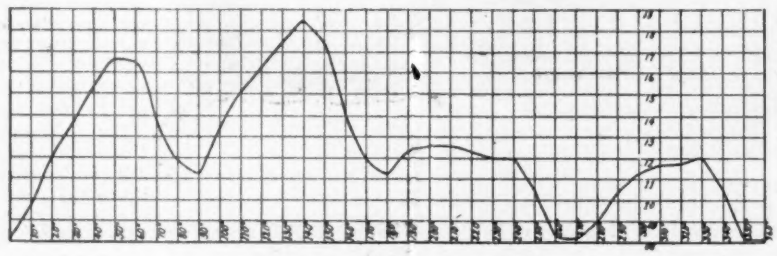


Diagram 3. Ratio of Total Rotative Force at Rail to Total Weight on Rail through one Revolution.

The coefficient of friction between wheels and rails or the coefficient of adhesion, is given by HASWELL as follows:

COEFFICIENT OF ADHESION OF DRIVING WHEELS.

Condition of rails.	European practice.	American practice.
Rails very dry	.3	.33
Rail very wet	.27	.25
Ordinary condition	.2	.222
In misty weather	.15	.2
In frost and snow	.09	.16

These figures are obtained by dividing the horizontal force applied to the wheel at the rail that is just sufficient to produce slipping, by the pressure of the wheel on the

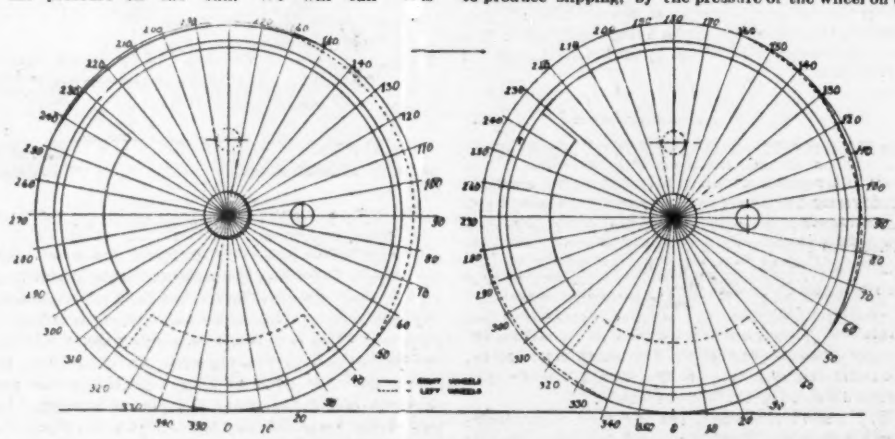


DIAGRAM 4. ACTUAL WEAR OF TIRES ON ENGINE No. 316, C., M. & ST. P. R. R.

TABLE I.—FORCES IN ACTION ON ENGINE NO. 316 MOVING AT 40 MILES PER HOUR.

Degrees.	Weight on rail. R. F.	L. F.	R. B.	L. B.	Total.	Rotative force at pin.	Ratio of rotative force at rail to weight on rail.
0.	13,500	19,230	13,500	17,340	63,570	12,910	.081
10.	13,216	18,974	12,836	17,282	62,308	15,283	.098
20.	12,985	18,702	12,187	17,105	60,979	18,377	.121
30.	12,831	18,237	11,580	16,825	59,470	20,467	.137
40.	12,742	17,598	11,035	16,441	57,815	22,268	.154
50.	12,733	16,811	10,559	15,965	56,068	23,407	.167
60.	12,539	15,979	10,175	15,420	54,113	22,378	.165
70.	12,052	15,049	9,895	14,813	51,809	17,924	.138
80.	11,799	14,079	9,718	14,164	49,760	14,365	.119
90.	11,632	13,500	9,660	13,500	48,292	13,793	.112
100.	11,578	13,216	9,718	12,836	47,348	15,879	.135
110.	11,545	12,985	9,895	12,187	46,612	17,530	.151
120.	11,555	12,831	10,175	11,580	46,141	18,733	.163
130.	11,599	12,742	10,559	11,035	45,935	20,004	.175
140.	11,724	12,733	11,035	10,559	46,051	21,108	.185
150.	11,945	12,539	11,580	10,175	46,239	20,222	.175
160.	12,228	12,052	12,187	9,895	46,362	16,279	.140
170.	12,641	11,799	12,836	9,718	46,994	13,870	.119
180.	13,500	11,632	13,500	9,660	48,292	13,793	.112
190.	14,575	11,578	14,164	9,718	50,035	15,308	.123
200.	15,648	11,545	14,813	9,895	51,901	16,290	.126
210.	16,397	11,555	15,420	10,175	53,847	16,938	.126
220.	17,641	11,599	15,965	10,559	55,764	17,179	.123
230.	18,495	11,724	16,441	11,035	57,694	17,496	.120
240.	19,232	11,945	16,825	11,580	59,582	18,105	.120
250.	19,408	12,228	17,105	12,187	60,928	15,745	.104
260.	19,311	12,641	17,282	12,836	62,070	12,779	.082
270.	19,230	13,500	17,340	13,500	63,570	12,910	.081
280.	18,974	14,575	17,282	14,164	64,895	14,712	.090
290.	18,702	15,648	17,105	14,813	66,268	17,137	.104
300.	18,237	16,397	16,825	15,420	67,179	18,672	.112
310.	17,598	17,641	16,441	15,965	67,645	19,443	.117
320.	16,811	18,495	15,965	16,441	67,712	19,796	.117
330.	15,979	19,232	15,420	16,825	67,456	20,261	.120
340.	15,049	19,408	14,813	17,105	66,375	17,390	.105
350.	14,079	19,311	14,164	17,282	64,836	13,274	.081

rail, and can be compared directly with the values given in the eighth column of Table I.

We will now proceed to apply the data given in Table I. to a case of wear taken from actual practice and illustrated in Diagram IV. The wear is shown by full lines for the right hand wheels and dotted lines for the left hand wheels. The depth of wear as shown is exaggerated to prevent confusion of lines, and shows just twice as great as the actual wear.

On the forward wheels there are two flat places of about the same size in the same location. This varies from the general results, as in most cases the flat place on the right wheel is much less than that on the left wheel, and there seems good reason to believe that the flat place on the right hand wheel has been modified by a soft place in the tire.

By referring to Table I, it will be seen that the coefficient of slip at 50° is .167 and that this exceeds the coefficient of adhesion for a frosty rail and that it approaches uncomfortably close to the coefficient of adhesion for ordinary condition of rail. The tendency to slip slightly or to what is known as imperceptible slip must be quite decided under these conditions.

A corresponding flat place is found on the left back wheel, but the right back shows no flat place. Several cases show some wear on the right back wheel corresponding with that of the left back wheel, but always less in quantity, and in this case doubtless more careful measurement would have shown some wear.

Considering the four flat places as shown in the neighborhood of 80°, why do they vary, always being greatest on the left hand tire? An inspection of the weight on rail seems to show the reason quite clearly. Table I shows the pressure of the four wheels on the rail at 60° to be as follows: L. F., 15,979 lbs.; L. B., 15,420 lbs.; R. F., 12,539 lbs.; R. B., 10,559 lbs., and the average size of the flat places correspond with these pressures. There are two other flat places on these wheels, one on the right back at 200°, and one at the left forward at 310°, which can scarcely be accounted for by slips, but are probably due to soft places in the tire.

As the speed of the engine increases, the coefficient of slip is varied by the increased intensity of the action of the centrifugal force of the counterbalance. A change in steam pressure and cut-off also affects these values.

There is a possibility that further and closer observations, covering a sufficient number of cases to eliminate the question of variation in the hardness of the tire, will develop the following: Flat places will be found near the 60° point, varying as shown above. Flat places will be found near the 140° point, where the coefficient of slip reaches .185, but much less than the preceding on account of light total pressure on the rail, and all nearly of the same size as the pressures of the wheels on the rail are all four nearly equal. Very slight flat places may also be found at the 220° point and the 320° point which are two other maximum points of the coefficient of slip.

It would appear from a comparison of the flat places with the weight on rail that when the pressure does not exceed 11,000 lbs. the tendency to abrasion from imperceptible slip is very slight.

The conclusions to be drawn from the above may be summarized as follows:

1. Flat places on driving wheel tires are not entirely due to lack of uniformity in their wearing quality.
2. The flat places have a tendency to group themselves where the coefficient of slip is greatest.
3. They vary in depth with the pressure on the rail, and when the pressure does not exceed 11,000 lbs. the imperceptible slip produces but little abrasion.
4. Imperceptible slip does not appear at random on any part of the wheel, but in special localities as fixed by the maximum values of the coefficient of slip.
5. The counterbalance should be as light as possible compared with the reciprocating parts, consistent with smooth riding.
6. The reciprocating parts should be as light as possible.

An English Steam Crane Excavator.

A steam crane excavator, now in use on the Manchester Canal, is illustrated in *Engineering*, of Jan. 16. The excavator is made at the Bankhall Engine Works, Sandhills, Liverpool. It is an ordinary 10-ton locomotive crane with an excavator bucket hinged to the crane a little below the central point of its length. The whole is carried on a steel truck with four wheels fitted to a 4-ft. 8½-in. gage and four additional wheels on the same axles fitting a 7-ft. gage.

The engines have two 8-in. cylinders with 12-in. stroke and link reversing gear. The boiler is vertical, 4 ft. 6 ins. by 10 ft. high, designed for 80 lbs. steam pressure. The excavator bucket has a capacity of 1½ cu. yds. The special feature of this excavator is the arrangement by which the bucket is fed up to its work. This is done by a steam cylinder bolted to the bucket arm and permitting an in-and-out motion of 2 ft. In practice, this machine can be used in cuttings 20 ft. deep and 40 ft. wide, and the output varies from 800 to 1,200 cu. yds. per day of 11 hours. The total weight of a *B*-machine, for working stiff clay, is 35 tons.

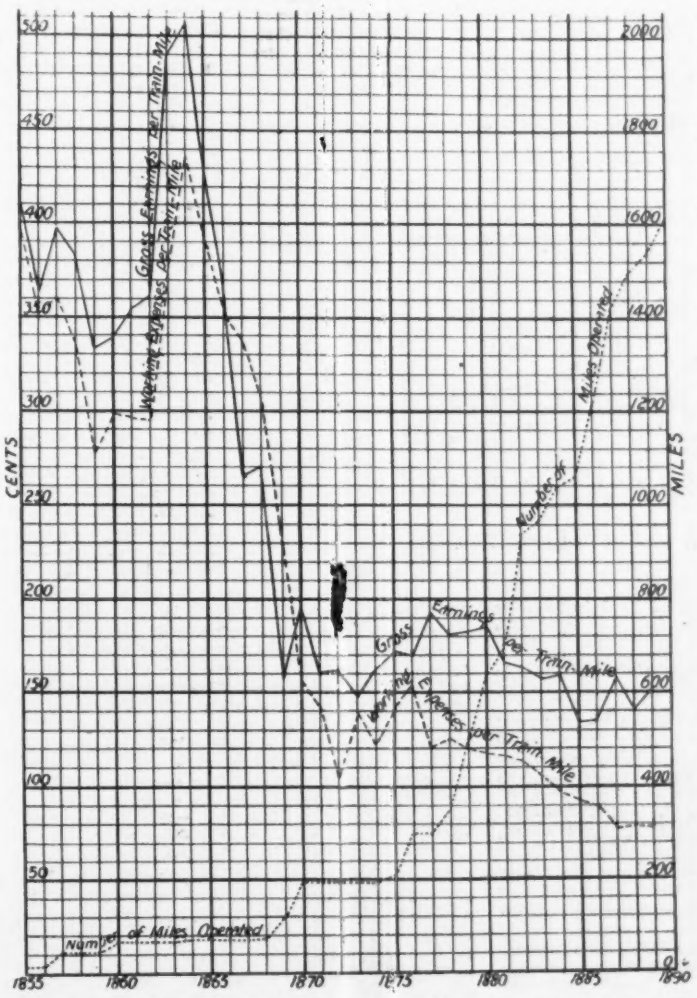


DIAGRAM OF GROSS AND NET EARNINGS, WORKING EXPENSES AND MILEAGE OF SOUTH AUSTRALIAN RAILWAYS.

South Australian Railways.

There are in Australia and the adjacent smaller islands 7 different colonies, as follows:

	Miles Ry.	Area.	Population.
New South Wales	2,263	310,700	1,122,200
Victoria	2,191	87,884	1,104,288
South Australia	1,756	903,690	319,604
Queensland	2,064	668,497	406,658
Western Australia	497	1,060,000	43,698
New Zealand	1,912	104,032	620,279
Tasmania	374	26,215	151,480
Total	11,057	3,161,018	3,768,107

We take these figures from the last issue of *Whitaker's Almanac* for 1891. The population and miles of railway are for the end of 1889, or beginning of 1890. Nearly all the railway mileage is owned by the government.

It will be seen that the total area of Australia is slightly larger than that of the United States, excluding Alaska. The population is still comparatively small, however, and is likely to always remain so, since the arable land fit for settlement is only a comparatively narrow strip along the coast, the interior being a rainless and still largely unexplored waste. The total debt of all the provinces is some $900,000,000, largely incurred for building railways and other public works, and the population is one of the most progressive in the world.

South Australia is one of the most important of the provinces in area and railway mileage, but one of the least important in population. The railway system consists of about 480 miles of 5 ft. 3-in. gage and 1,276 of 3 ft. 6-in. gage, the narrower gage being all of the more recent construction. The official reports are very complete in their details but unhappily not so digested and abstracted that it is possible to make a comparison between the operating results with the narrow and the broad gage without much more labor than we are prepared to give to it.

We abstract from the last annual report of the Railway Commissioners for the year ending June 30, 1890, however, the accompanying diagram (slightly changed in form) showing the receipts and expenses per train mile and the total miles operated for each year since railway operations began in the province; and we also abstract from the report the following operating records, to which we have added the corresponding records for the American railway system, for purposes of comparison:

	South Australia.	United States.
Miles open at close of year	1,610	161,306
Passenger traffic—		
Receipts per passenger mile	1.52c.	2.17c.
" " train mile	10.44c.	92.80c.
Passengers per train	44.7	42.8
Miles per passenger	13.62m.	24.17m.
Receipts per mile of road	$972	$1,771
Freight traffic—		
Receipts per ton mile	3.56c.	0.976c.
" " train mile	190.18c.	154.7c.
Tons freight per train	53.5	159 3
Haul per ton	79.73 m.	110.8 m.
Receipts per mile of road	$2,210	$4,365
All traffic—		
Receipts per train mile	151.64c.	137.2c.
" mile of road	$3,192	$6,574
Expenses per train mile	76.84c.	93.3c.
Per cent. of expenses to earnings	50.68%	67.9%
Population per mile road	204	368
Number employees	3,394	704,743
" per mile	2.108	4.467

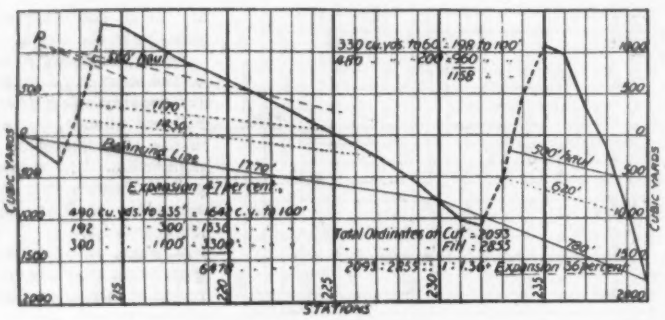
It will be seen that the passenger traffic is handled

under much the same conditions and with much the same results in South Australia as on the average American railway. In freight traffic, however, there is an enormous difference. The average rate is nearly four times as high in South Australia, and the average train load only one-third as great. Consequently, the receipts per train mile are somewhat greater, the expenses per train mile noticeably less, and the expenses only 50.7% instead of 67.9% of the receipts, which argues that rates are maintained at an unduly high point, the invested capital per mile of road being very moderate.

Estimating Overhaul in Earthwork by means of the Profile of Quantities.

As the method described in the article under the above title, contributed by Mr. FISHER to ENGINEERING NEWS of Jan. 31, was not entirely clear to some of our readers, Mr. FISHER has favored us with the following fuller explanation of the process outlined in the last paragraph of his former article:

Prolong that portion of the balancing line in the accompanying figure, which passes through stations 230 and 240 to the point *P*, its intersection with the horizontal through 235; the lines of haul are drawn from this point to each point of flexure of the dotted



PROFILE OF QUANTITIES.

and solid curves. The limit of haul is fixed by making the horizontal distance between the upper intersection 500 ft.

The expansion and contraction of the material is shown by the relation between the extreme ordinates of the solid and dotted curves, as shown in the figure. The balancing line is nearly always more or less inclined. It is horizontal only when the volumes of the adjacent cut and fill are equal to each other. The point *P* will not usually come on the limits of the drawing, and it is only in the rare instances of great expansion or contraction of material that it is needed in practice. The inclination of the balancing line is generally so slight that the lines of haul can be drawn parallel to it or a trifle divergent.

The Advantages of Large Furnaces.

At a late meeting of the Engineers' Society of Western Pennsylvania a paper was read by Mr. H. D. HIBBARD on "Defects in Design of Open-Hearth Steel-Melting Furnaces." In discussing this paper the maximum size at which an open-hearth furnace could be built and successfully run was brought to question. The author thought that this was a feature to be governed entirely by the size of ingot to be made. He thought that a 100-ton furnace was practicable, but hand-tools would become so large and unweildy that some kind of machinery would have to be devised to take their place.

Mr. WM. METCALF said that from an economical standpoint he never saw a furnace too big. During the late war necessity compelled the firm with which Mr. METCALF was connected to build what was then classed as an absurdly large furnace, and the army officers and others thought that it would be impossible to melt the large mass of iron proposed without ruining it. The "kitchen" of that furnace was 7 ft. high, 11 ft. wide and 17 ft. long in the clear. It was an ordinary coal furnace, but it was quite common to charge 40 tons of iron in this furnace and to sometimes put in a whole gun. Starting with the furnace cold in the morning, the charge would be melted in from 3½ to 4 hours.

For one year Mr. METCALF kept an accurate account by weight of the fuel used in different furnaces. Speaking from memory, he said the results were as follows: A 10 ton furnace required for melting about 16 bushels to a ton of iron; the 15-ton furnace would melt with 13 bushels; the 25-ton furnace, of an improved model, took 7 to 8 bushels, and the 40-ton furnace described, from 4½ to 5½ bushels per ton of iron. As to lasting qualities, the speaker said that the big furnace would run as long as the others. The average life was only about 6 or 8 weeks; because being coal furnaces, a new sand-bottom had to be made every day. They were charged cold every morning and fired with the draft from a stack, 11 ft. in diameter and 70 ft. high, for the 40-ton furnace.

The Siberian Railway.

The *Magdeburg Zeitung* gives some interesting particulars concerning the plans which have been suggested for the projected railway across Siberia to the Pacific. There were two divergent schemes. One advocates an uninterrupted line, starting from Tjumek, in the Urals, and having its eastern terminus at Vladivostock. This would be at least 8,000 versts long, and the lowest estimate places the cost at 340,000,000 roubles. The other scheme recommends a system of comparatively short railways, combined with the great waterways which have hitherto been a chief factor in commercial communications through Russian Asia. This, it is estimated, could be completed for 120,000,000 roubles, or for a little more than a third of the cost of the more ambitious project. The western terminus of the system would be at Tomsk, which is already connected by rail with all the chief points in European Russia. The railway to Irkutsk, close to Lake Baikal, will be 1,568 versts long. Another line from the south-eastern end of the lake to Szetensk and the Amoor will be 1,000 versts long, and its continuation from Grafsikaja to Vladivostock will be 383 versts. This line of communication, it is true, will be available only during the summer half of the year. But the experience of what actually goes on in the Volga region, where, notwithstanding the railway facilities, all trading operations are confined to the period within which navigation is feasible, shows that a summer system of communication will be quite sufficient for Siberia, where trading operations and development of every kind are so much less. A long series of observations shows that both the Obi and the Irtysh are open for navigation about 190 days in the year, which will give much more than sufficient time for the cheaper conveyance of everything by water from one railway terminus to another. At all events, this combined system of railways and navigable rivers will suffice for all Siberian demands for a long time to come. It is rumored, the *Magdeburg Zeitung* states, that the railway from Tomsk to Irkutsk will be taken in hand this year, and that a loan will not be needed, at least in the first instance, for its construction; the funds will probably be obtained from the accumulation of savings during the last few years. The German paper proceeds to give estimates in detail of the probable income of this new system, in which the revenue to be derived from the carriage of tea is put down as a considerable item. At pr sent all tea which comes from China to Russia is carried by water, with a comparatively small distance of land transport, all the way to Nishni-Novgorod.

PERSONALS.

Dr. NICHOLAS AUGUST OTTO, inventor of the Otto gas engine, died at Cologne, Germany, Jan. 27, aged 55.

Mr. A. N. TALBOT, of Champaign, Ill., has been elected president of the Illinois Society of Civil Engineers & Surveyors.

Mr. THOMAS CAMPBELL has been appointed Receiver of the International & Great Northern Ry., vice Col. EDDY, deceased.

Mr. F. P. DEWEY, M. Am. Inst. Mining Engineers, and late Curator, Department of Metallurgy, U. S. National Museum, has established a chemical and metallurgical laboratory in Washington at 621 F St., N. W.

Mr. ELWOOD S. SCHEETZ has been appointed Master Car Builder of the Georgia R. R., vice Mr. T. M. PREVAL, assigned to other duty.

Mr. W. C. ARP, of Logansport, Ind., has been appointed Master Mechanic of the shops of the Pittsburg, Cincinnati & St. Louis Ry. at Dennison, O.

Mr. J. C. HAGGETT, Master Mechanic of the Dunkirk, Allegheny Valley & Pittsburg R. R., has resigned. He will be succeeded by Mr. W. G. TABER, formerly Master Mechanic of the New York & New England R. R.

Mr. L. F. WAKEFIELD has been appointed Chief Engineer of the Sioux City & Northern R. R., vice Mr. A. K. SHURTLEFF, resigned. Mr. WAKEFIELD retains his position as Chief Engineer of the Sioux City North-western R. R.

Messrs. W. L. FINDLEY, C. F. QUINCY and ARTHUR CRANDALL have organized the Q. & C. Co., of Chicago, New York, and Montreal, as successors to the Dunham Manufacturing Co., well known throughout the railway trade in this country.

NEW PUBLICATIONS.

—*The Theory and Practice of Surveying.* Designed for the use of surveyors and engineers generally, but especially for the use of students in engineering. By J. B. JOHNSON, C. E., M. Am. Soc. C. E., Prof. C. E. Wash. Univ. Seventh revised and enlarged edition. New York: John Wiley & Sons; 8vo, pp. 730, 108 cuts, 12 tables, $4.

This seventh edition of what has already become a standard work contains some important additions and corrections. The chapter on Land Surveying has been entirely recast, as also the description of the U. S. Land Surveys. An important addition is a new method for determining azimuth at any hour from polaris, which will be found very convenient on all kinds of surveys. The method was devised originally by Mr. J. B. SHINN, of the U. S. General Land Office, and, by an ingenious arrangement of tables, only two pages are required to give all necessary data for determining the azimuth of polaris at any day, hour, minute and year until 1900, or with very trifling error until 1910. We have on many occasions suggested that such a method was possible, and should be perfected and tabulated, and we are only surprised that this has not been done before. It appears to us that the method is capable of still further simplification, but perhaps it would not prove simpler in use, and the form given is simple enough for practical purposes. The short sentence which ends at the top of p. 541 is bad in form at least, if not in substance.

The short introduction of three pages with which the work opens is admirable in its form and spirit, pointing out clearly the difference between compensating and cumulative errors, and the folly not to say dishonesty, of pretending to a greater accuracy than exists by carrying out results to many decimals. It would afford us satisfaction, and might perhaps be of interest to many readers to again review the work throughout, in which there is much more to approve of than to criticise, but as we have noticed prior editions with some fullness, it is hardly necessary that we should do more now than to again commend the work as an excellent manual which has now become a better one than ever before.

—*General Index of the Annual Reports of the American Railway Master Mechanics' Association.* Prepared by ANGUS SINCLAIR, Secretary. New York, 1891. Published by the Association. Pamphlet, pp. 62.

This index covers the 23 annual reports of the Association which have thus far been issued. The compiler has indexed reports, papers, illustrations and discussions separately, and has also made a general index to the whole, which he has wisely made much fuller than the others, occupying two-thirds of the pamphlet. With this index those who are fortunate enough to have a complete file of the reports have now quite a complete cyclopedia of locomotive design, and the topics related thereto. It is by no means an infallible one, and there is very much that is contradictory and obsolete in it; but it has the great merit of being a record of practical experience, and this index, which makes it available for reference, is a real boon.

—*Second Biennial Report of the Minnesota Bureau of Labor Statistics.* JOHN LAMB, Commissioner, St. Paul, 1890. Paper 6 × 9 ins. pp. 377, with tables and illustrations.

This is one of the best reports of a State Labor Bureau that has come to our notice. The subjects investigated are "School Attendance," "Child Labor," "Manual and Technical Training," "Workingmen's Earnings and Expenses," "Mine Inspection," "State Labor Laws." The commissioner does not confine himself in his report to existing conditions in Minnesota, but quotes largely the results of investigations in other States and abroad. The chapter on manual training gives a full account of the work in progress in this direction in the schools of Minneapolis, St. Paul, Stillwater and Duluth, as well as in the more important schools in other States.

—*Annual Reports* have been received as follows:

General municipal reports: Middleborough, Mass., J. E. BEALS, Water Commissioner; Pittsfield, Mass., J. M. HATCH, Superintendent Water-Works; Wichita, Kan., H.

H. JACKMAN, City Engineer. Water-Works reports: Woodsville, N. H., E. B. MANN, Superintendent: Fitchburg, Mass., T. C. LOWELL, Superintendent; Lockport, N. Y., R. J. STERRETT, Superintendent; Trenton, N. J., C. A. REID, Secretary; Manhattan, Kan., G. E. HOPPER, Superintendent; Annual Report upon the Washington (D. C.) Aqueduct, Water Supply District of Columbia, &c., in charge of Lieut.-Col. G. H. ELLIOT and Lieut. Col. J. M. WILSON.

—*The American Patent System*. A Practical Guide to the Inventor and the Investor in Patents. By D. WALTER BROWN, New York. Published by the Author. 16mo, pp. 61; 25 cents.

This is a reprint of a series of articles in the *American Machinist*, and contains useful elementary hints on patent procedure.

—*Proceedings of the Eighth Annual Convention of the Roadmasters Association of America*. JNO. P. RAMSEY, Muncie, Ind., Secretary. Pamph., 93 pp., with several illustrations of interlocking machines and rail joints.

Members of the Association will doubtless examine this report with interest to see if it is as full of errors as the report of the preceding year's convention, concerning which so much fault was found at the Detroit meeting. While the report is by no means free from errors, they seem to be due to the proofreader rather than the stenographer or editor. On the whole, considering the great difficulty in taking accurate stenographic reports of such a meeting and translating them from what the speakers meant to say to what they actually did say, the stenographer and editor deserve praise for their work. The proceedings of the convention were fully reported in our issues of Sept 13 and 20, 1890.

—*Annual Report of the Columbus (O.) Water-Works*. Superintendent and Chief Engineer, W. H. MCALPINE. Pamph., pp., 40.

This report contains very complete pumping statistics, in detail, for the years 1889-90, and less full for the years 1872-3 to 1889-90. There is also a table showing in detail the disbursements for the works for the 20 years ending March 31, 1890, and some additional statistical matter of value.

—*Report of the Water Commissioners of Detroit* (Mich.). Secretary, I. N. CASE.

Some very interesting facts regarding the use of meters are given in this report. The number of meters was increased during the year from 198 to 856, or by 658. In two years the average daily consumption has been reduced by 6,000,000 galls., and the daily consumption per capita from 204 to 155 galls. The pumping and other statistics in the report are quite complete. Experiments with natural gas began in December, but had not been completed at the time the report was made.

TRADE PUBLICATIONS.

—*Pecora Mortar Stains*. S. BOWEN'S SONS, North Penn Junction, Pa. 15¼ × 42 ins. 11 plates.

This is a manufacturer's catalogue which very few readers will consign to the waste basket. It consists of 11 finely printed engravings, mostly direct reproductions from photographs, showing various buildings of recent erection in which the Pecora stains were used in the mortar. Among them are Osborn Hall at Yale College, the Wisconsin Central Passenger Depot at Chicago, the University Building at Allegheny, Pa., and the California Academy of Sciences at San Francisco.

—*Street Railway Roadbeds*. R. T. White, 52 Wall St., New York.—An illustrated catalogue showing the "Daisy" chair, of cast-iron or steel, for use with T or girder rails of various types for street railways. The pamphlet also illustrates and describes a decidedly novel form of cable conduit construction, in which the conduit is carried on a series of short cast-iron posts, and the two conduits and the tracks are so connected by I-beams that closing of the slot is absolutely prevented. The method is fully shown and the details are well worked out. The catalogue gives a list of 21 street railways employing the patent chair, and shows that 180,036 are now in use, though the patent is not yet one year old.

SOCIETY PROCEEDINGS.

Technical Society of the Pacific Coast.—The following officers were elected at San Francisco, Cal., Jan. 23: President, John Richards, mechanical engineer; Vice-President, Luther Wagner, civil engineer; Treasurer, Geo. F. Schild, naval architect; Secretary, Otto Von Geldern, civil engineer; Directors, Hermann Kower, civil engineer; Ross E. Browne, mining engineer; C. R. Grunsky, civil engineer; Jas. W. Reid, architect; Alpheus Bull, mechanical engineer.

Alabama Industrial and Scientific Society.—This new technical organization was organized at Tuscaloosa, Ala., in December. The second meeting was held at Birmingham, Jan. 28, at which about 40 were present. The President, Cornelius Cadle, Jr., of Blockton, delivered an address and papers were read by A. W. Haskell on "Mine Surveying," and by Joseph Squire on "The Cahaba Coal Field." A constitution was adopted and resolutions were passed asking the Legislature of Alabama to appropriate $30,000 for a more rapid geological survey of the State. Meetings of the Society are to be held quarterly. The next meeting will be held at Anniston on Wednesday, April 8. Mr. W. B. Phillips is the Secretary.

Engineers' Club of Cincinnati.—At the regular meeting, Jan. 15, 35 members and several visitors were present. Messrs. Louis Zepernich and John W. Cowper were elected members. The committee appointed to investigate the advisability of the club becoming a member of the Association of Engineering Societies presented its report, and after some discussion of the subject it was decided that the club defer the matter for the present. Mr. Edwin A. Hill, real estate agent of the C. C. C. & St. L. R. R., read a paper on "Office Records."

Central Railway Club.—The quarterly meeting was held Jan. 28 at the Iroquois Hotel, Buffalo. The amount of fastening necessary on center plates for the acceptance of cars in interchange was discussed. It was voted that at least two effective bolts at points opposite each other should be required for the acceptance of a car. The committee appointed at the last meeting to consider what amount of breakage of coupler or knuckle should cause the rejection of a car fitted with M. C. B. couplers reported that cars should be rejected if the knuckles were broken or chipped in any manner. Diagrams were submitted showing the amount of breakage of the draw bar which should cause rejection. The report was adopted as the sense of the meeting. The following officers were then elected: President, Eugene Chamberlain; Vice-President, F. B. Griffith; Secretary, John McBeth.

Illinois Society of Engineers and Surveyors.—Sixth annual meeting held at Springfield, Ill., Jan. 27-30. President Arthur N. Talbot, presiding. Among the papers read were the following: "Improvement of Public Grounds," S. F. Balcom; "Cumberland Gap Tunnel," Jas. F. Parr; "Distance to the Stars and How Found,' Prof. Ira O. Baker; "Roads and Road Drainage," T. S. McClannahan; "Metric System;" "Pennington's Aerial Ship," G. C. Harvey; "Peoria Water-Works," Jacob Harman; "Durability of Iron Water and Gas Pipe Underground," Charles G. Elliott; "Office Records,' E. A. Hill; "Map Making," W. W. Abell; "Principles of the Electric Motor," C. J. Mitchell; "Determining True Standard Time at any Place in the United States," D. H. Davidson; "Streets and Sidewalks," G. F. Wightman; "Drainage and Sewerage of the Town of Cicero," J. W. Alvord; "Safety Appliances in Railway Travel," Chas. Hansel; "Brick or Stone Culverts vs. Trestle Work," J. A. Allen; "Raising of Flood Level in Creeks by Silt Deposits, and How to Apportion Expense of Counteracting," E. J. Chamberlain; "Surveying Problems," D. L. Brancher. The following officers were elected for 1891: President, Arthur N. Talbot; Executive Secretary and Treasurer, S. A. Bullard; Recording Secretary, C. M. Richards; Chairman of Executive Board, D. L. Brancher.

Western Railway Club.—At the meeting on Jan. 20 Mr. D. L. Barnes' paper on "Vertical Plane Couplers and Air Brakes," (see ENGINEERING NEWS, Jan. 3), was discussed. Mr. Barnes gave additional results of examination of the slack in M. C. B. couplers. This he had found to average 1¼ ins. in a number of cars, the coupler being drawn out or pushed in by the strength of one man. By attaching a locomotive the slack was shown to be as high as 2 ins. in some cases, not including the compression and extension of draft springs. Observations on link slacks had shown it to vary from 1 to 4 ins. An examination had also been made of the automatic couplers on ore cars of the Chicago & Northwestern R. R., which had been in service since April, 1890, and had made an average of 12,000 miles. The average wear of the knuckles was ⅛ in. on the interior face. This the author presented as showing that his estimate of five to six years as the probable life of knuckles before wearing out was a conservative one. This, however, was no excessive wear, and the author believed that the vertical plane coupler is "the best device ever produced for coupling trains."

A discussion of the paper was presented by Mr. W. H. Marshall. He referred especially to the need of better governors for air brake pumps, which would never allow the pressure to rise above the standard 70 lbs. He gave instances of pressures of 90, 100 and even higher pressures being carried in air brake reservoirs. Instead of reducing leverages of brake connections or putting pop valves on air cylinders, the governor should be attended to and the standard pressure of 70 lbs. should be adhered to.

Another cause of flat wheels is too close adjustment of the piston travel. When the slack is taken up in the brake gear the travel should never be less than 6 or 7 ins. The advantages of an automatic adjuster for the slack in air brake rigging was also referred to.

Concerning M. C. B. couplers, Mr. Marshall claimed that the figures of excessive wear given in Mr. Barnes' original paper were taken from passenger service, where conditions are wholly unlike those in freight service. He presented some evidence showing that the wear of the knuckles was very moderate, and that if the knuckle retains nearly its original contour, and does not wear to a wedge shape, as claimed by Mr. Barnes, there is no especial need at present for a code of rules specifying allowable wear of knuckles in interchange; and the matter of conformity to contour lines should also be allowed to settle itself. No coupler company can do business long if its couplers cause trouble from non-adherence to the lines. The tensile strength of M. C. B. couplers has been much increased, and will now average much above 80,000 lbs.

Mr. Rhodes called attention to the new rule adopted at the last meeting of the M. C. B. Association, by which it is not necessary for a road to carry all kinds of M. C. B. couplers in stock to repair foreign cars. Only the knuckles need be kept, and broken drawbars can be replaced with any M. C. B. drawbar equal in strength to the one broken. He opposed the position that use of the vertical plane coupler was not important to the successful use of the air-brake, and urged that both be applied at the same time. He felt sure that any one using the best forms of the vertical plane coupler need not worry as to its ultimate success; but he emphasized the need of strict adherence to the contour lines. Mr. Vertryck supported Mr. Rhodes' statements, and said he had refused vertical plane couplers which were off the M. C. B. lines. After some further remarks it was agreed to continue the discussion at the February meeting.

A paper on "Irregular Wear of Locomotive Tires" was then read by Mr. J. N. Barr. It will be found in another column. At the next meeting, on Feb. 17, a paper on "Car Lighting" will be read by Mr. Geo. Gibbs. At the March meeting Mr. Hickey will read a paper on "Boiler Construction."

American Society of Civil Engineers.—The regular monthly meeting was held Feb. 4. Mr. Chas. B. Brush, Director, in the chair. Mr. F. Collingwood, Secretary. A letter was presented from Mr. W. R. Cock calling attention to the improved clip for testing cement briquettes, which was described and illustrated in ENGINEERING NEWS, Dec. 20, 1890. The paper on "The Howe Strut Problem," by Mr. N. J. Conover, was stated to be of too mathematical a character for presentation at the meeting.

A brief paper on "The Use of Asphaltum in Building Sea Walls," by Mr. W. C. Ambrose, M. Am. Soc. C. E., was read by the secretary. It referred to the construction of a wall on the Southern Pacific Ry., where the line runs along the coast. The wall is founded on the rock, and is built of round bowlders found on the shore; it is 6 ft. wide at the base and 2 ft. wide on top, and is cemented to a depth of 2 ft. from the face with asphaltum poured in hot. The asphaltum was obtained from the California bituminous rock, which is much used for paving; it is composed of 24.4% bitumen and 75.6% of ash. The cost was about $10 per ton. The cost of the wall was about $3.75 per cu. yd., exclusive of the old ties used for fuel, and of the transportation of the asphaltum for 28 miles. The asphalt becomes soft in hot weather, but is kept cool when the tide is up by the spray from the waves.

In the discussion, Mr. E. H. Wootton, agent for the Seyssel rock asphalt, stated that he had made asphalt cement blocks of rock asphalt mastic and broken stone for engine foundations. Rock asphalt will not soften under any temperature if in very large masses, but the expense of using the European asphalt for sea walls would be too great. Injunctions having been brought against the Seyssel company in Paris, about ten or fifteen years ago by a glass engraver, on account of the injury to his business by the vibrations from a Blake rock crusher the company built asphalt concrete foundations for its machinery; and since then no complaints have been made. Capt. F. V. Greene stated that an asphalt concrete foundation of about 30 cu. yds. had been built for a 3 ton trip hammer at Tiffany's works, in New York City, to prevent injury to glassware; it was composed of 1 part of asphalt, 2 of sand and 4 or 5 of 2-in. broken stone; the materials were heated separately, then mixed and tamped in 5 in. layers. The cost was about $27 per cu. yd. In regard to the use of tar, the principal objection was its oxidization, by which it loses the oil. He thought it would be durable in large masses, as the oxidization is only at the surface. The floor of the Washington Bridge, New York, is composed of 5-in. layers of stone well sprinkled with tar, then covered with tar concrete, which forms a foundation for the asphalt wearing-surface. There are so many uses for tar now, however, that it costs $16 to $17 per ton here, and $18 to $20 in the interior, so that asphaltum at $10 per ton would be cheaper. Mr. North referred to the great difference in quality of various kinds of asphalt; some of that found in California requires the addition of more bitumen to make it suitable for paving purposes. Mr. Cooper pointed out that the principal feature in the sea wall described in the paper was the use of a plastic mortar or cement, so that the wall would not be disintegrated by the action of the waves, as it would be if ordinary cement were used. The use of the asphalt did not make the wall itself any stronger than if cement had been used, but made it more durable by being better able to resist the disintegrating action of the waves.

The secretary presented a colored plan showing the various pipes, conduits, etc., at the intersection of Broadway and Fulton St., New York; it was similar to the plan given in ENGINEERING NEWS, Nov. 1, 1890. The Secretary also announced that he was out of papers, and requested members to send in contributions.

The following candidates were declared elected: *Members:* Patrick J. Flynn, Tulare, Cal.; Conway B. Hunt, Asst. Eng. Dept. of Streets, Washington, D. C.; Norton L. Taylor, Tacoma, Wash. *Junior:* Maurice A. Viele, New York.

ENGINEERING NEWS

AND

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Geo. H. Frost.....Business Manager

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—Next meeting, Feb. 7. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Cincinnati.—Next meeting, Feb. 9. Secy., J. F. Wilson.

Civil Engineers' Club of Cleveland.—Next meeting, Feb. 10. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Feb. 11. Secy., F. M. Curtis.

New England Water-Works Association.—Annual meeting, Feb. 11, at Young's Hotel, Boston. Secy., R. C. P. Coggeshall.

Engineering Association of the Southwest.—Next meeting, Feb. 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—Next meeting, Feb. 13. Secy., D. W. Meeker, St. Paul, Minn.

Western Railway Club.—Next meeting, Feb. 17. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 17. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Feb. 18. Secy., S. E. Tinkham.

Engineers' Club of St. Louis.—Next meeting, Feb. 18. Secy., Arthur Thatcher, Room 901, Odd Fellows' Building.

American Society of Civil Engineers.—Next meeting, Feb. 18. Secy., Francis Collingwood, 127 E. 23d St., New York.

Northwest Railroad Club.—Next meeting, Feb. 19. Secy., H. P. Robinson, St. Paul, Minn.

New York Railroad Club.—Next meeting, Feb. 19. Rooms, Gilsey House. Secy., H. G. Prout.

Denver Society of Civil Engineers.—Next meeting, Feb. 24. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting, March. 2. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, March 3. Secy., J. W. Weston, 250 La Salle St., Chicago.

Technical Society of the Pacific Coast.—Next meeting March 6. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Association of Kansas.—Next meeting, March 11. Secy., J. C. Herring, Wichita, Kan.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July-December, 1890), is now in press, and will be issued about March 15, in a separate small volume, handsomely bound in cloth, which will be sold at $1. Orders for the index will now be received. It has been carefully compiled, and will contain references to every technical article of any importance which has appeared in this journal from its first issue up to date. The character of each article, whether illustrated, editorial, correspondence, news note, etc., will also be indicated. It will, therefore, prove a valuable work of reference even for those whose files are not complete.

EXCEPT for the repeated disappointments of the past, it would appear as if true rapid transit for New York was now in sight. A bill giving all necessary powers to the existing Commission passed both houses of the legislature unanimously, and has since been signed by the Governor. The franchises for the lines which the Commission determines should be built are to be sold at auction, and unless it should prove that there is no one willing to accept such franchises on any terms, which is hardly likely, it is all but certain that one or more new lines will soon be under way. A way is also opened for effecting some needed improvements of the older lines, notably the third track which the Manhattan Company has been seeking to add for years, and which will improve both the quantity and quality of the service by making express service possible.

The line which seems the surest to be at once laid out and undertaken is the extension of the New York Central tracks down Fourth avenue, Lafayette Place and Elm street to the City Hall and Battery, which is an urgently needed improvement, not only nor chiefly to relieve the present city service, but to add to the effective area of the city the "annexed district" beyond the Harlem River, which is now so difficult of access as to attract little more than a country village population. With express train service direct from this district to the City Hall and Battery, an immense population will speedily be attracted to it, which before many years may easily exceed the population on Manhattan Island itself. It is to be hoped that this will be realized in planning the proposed improvement, so that it may not find itself choked almost from the beginning by an excess of traffic.

THE Indian problem is shown by Census Bulletin No. 25 to be in a fair way to settle itself as did the great case of Jarndyce vs. Jarndyce, by extinguishment of the cause of dispute. All comparison with prior statistics is avoided in the census bulletin, but by referring back to the census of 1870 (we find no corresponding record for the census of 1880) the Indian population seems to have changed as follows:

	1870.	1890.
Nomadic uncivilized Indians	234,740	8,846
In tribes on reservations	123,241	133,382
Self-supporting Indians on reservations		74,478
Out of tribal relations and taxed or taxable	25,731	32,567
Total U. S. Indian population	383,712	249,273

Alaska is not included in these statistics. It will be seen from them that while the civilized non-tribal fraction of the Indian population a little more than holds its own, the entirely uncivilized nomadic element has all but dissappeared, and nearly half the total remaining Indian population are now self-supporting. It is but a short step further to finally abolish the tribal relation, make each Indian a liberal allotment of land in severalty for his maintenance, making his land inalienable for a term of years, sell the remainder of the reservations for his benefit, the fund being held in trust for a certain number of years; and then let the Indian take his footing as a citizen on equal terms with the white and colored race, and live or die as his personal wisdom or folly may determine. In this way the complete disappearance of the Indian race from the continent would be likely to be checked. Otherwise there will soon be but a handful left. Within the last 20 years, it will be seen, the race has decreased by more than one-third.

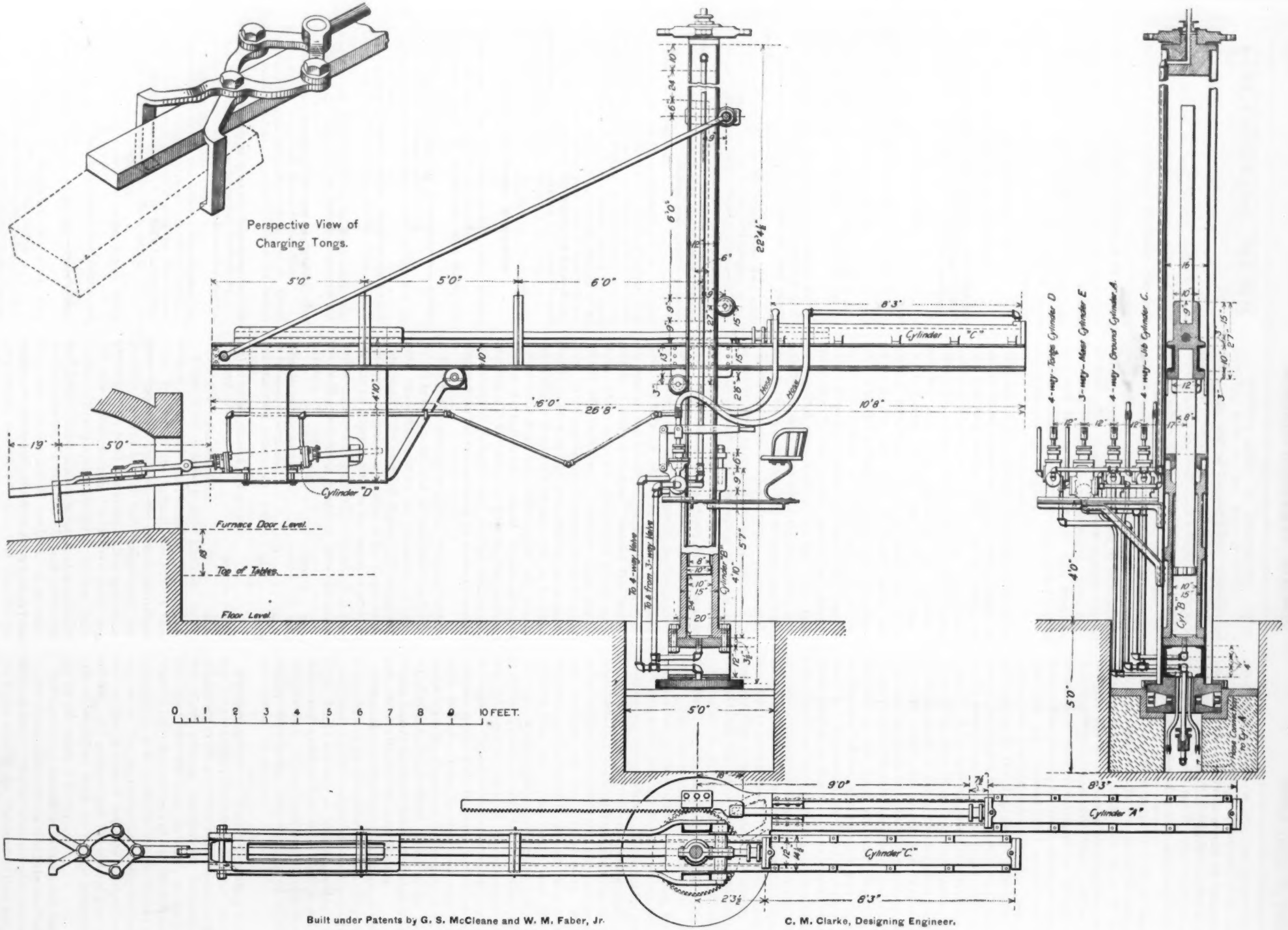
A PECULIAR case of irregular wear on locomotive tires, claimed to be not at all uncommon, is discussed in another column by Mr. J. N. BARR. Evidence has been presented showing that certain American type locomotives, rather heavily counterbalanced, develop flat spots on the left front driver when running on roads in sandy districts. That this has occurred, and under conditions which prove it to be due to some other cause than soft material in the tire, seems to be fairly well proven, although it has not been shown, so far as we are aware, that its occurrence has been at all general. It has been suggested that this was due to the lifting effect of the counterbalance weight at certain points of the revolution when the pressure on the crank pins approaches its maximum. This may so reduce the pressure of a single wheel on the rail that the ratio between it and the rotative force on the crank pin may fall below the coefficient of adhesion, when what may be designated as "infinitesimal slip" may take place. Mr. BARR alludes to this as "imperceptible slip," a term which has been generally used to denote a supposed considerable slippage of driving wheels at high speeds which has been pretty conclusively shown to be non-existent. It may very likely be, however, that a certain small motion does take place between the wheel tread and the rail when the engine is pulling, through the bending of the fibers of the surface on both tire and rail. The microscopic structure of these surfaces may be likened to a velvet plush, the pile of which would permit a motion between two surfaces having rolling contact. Whatever the motion which takes place between the rolling surfaces, it is probable that abrasion does take place to some extent without perceptible slip, and that the abrasion increases with the tractive force. It may, therefore, quite possibly be that the ratio between rotative force and wheel weight does influence the wear, which would necessarily vary, therefore, at different points on the tire. The observed fact that the large flat spot on the left main driver develops on engines when run on sandy roads, and does not appear when the same engines are run on other divisions, seems to show that any motion which takes place between the surfaces of rail and wheel must be infinitesimal. Sand on the rail, of course, largely increases the coefficient of friction, and prevents the drivers from slipping.

The practical conclusions which Mr. BARR reaches at the close of his discussion are that the reciprocating parts and the counterbalance, especially the latter, should be made as light as possible. With this recommendation there is not likely to be much disagreement. A very good way to begin lightening the reciprocating parts would be to substitute steel pistons for cast-iron.

THE managers of the World's Columbian Exposition have suddenly discovered that not less than $15,000,000 will answer their requirements, not less than $7,000,000 being required for the buildings, and only $9,928,000 being in sight, $4,928,000 of which is the collectable part of a $5,600,000 popular subscription, and $5,000,000 is to be derived from city bonds. One proposition for raising the further sum required is to bond the gate receipts for $5,000,000; and another, and the favored plan, is to raise $5,000,000 on stock by further subscriptions among the people of Chicago.

If this amount is actually to be raised and expended, the Chicago Fair ought at least to be the "biggest show on earth," whether it is a complete success in the higher sense or not. Little more than half this sum has been demanded for the great preceding expositions. The Paris Exposition of 1889 was

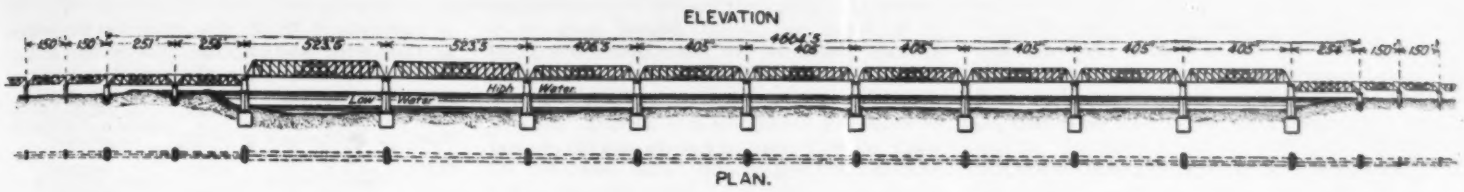
Perspective View of Charging Tongs.

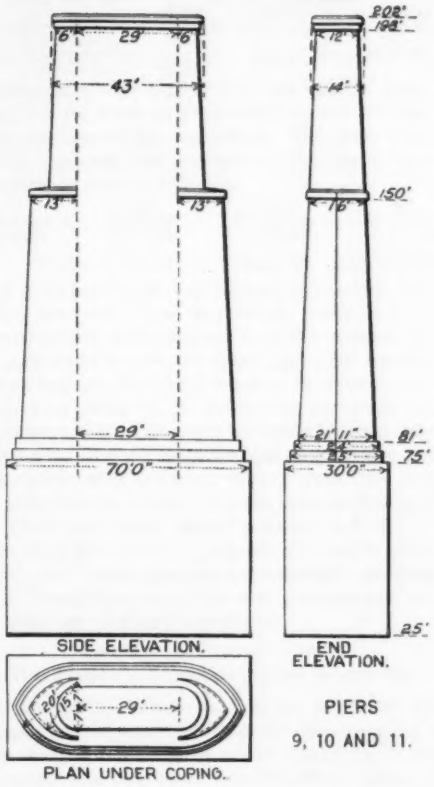


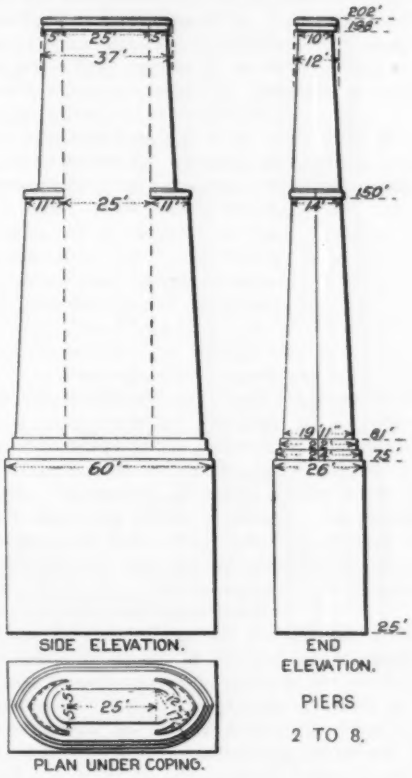
Built under Patents by G. S. McCleane and W. M. Faber, Jr.

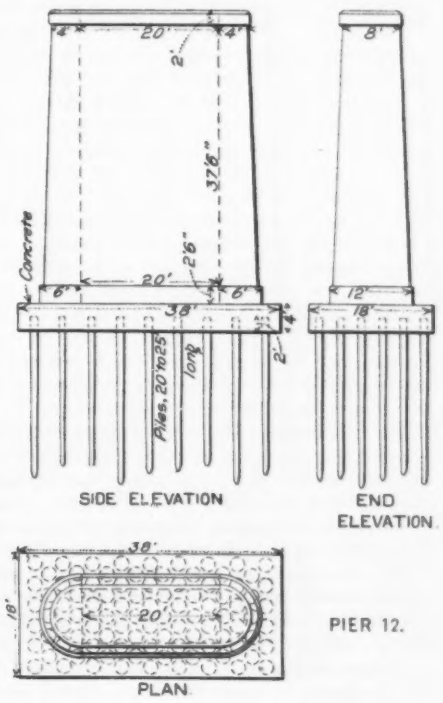
C. M. Clarke, Designing Engineer.

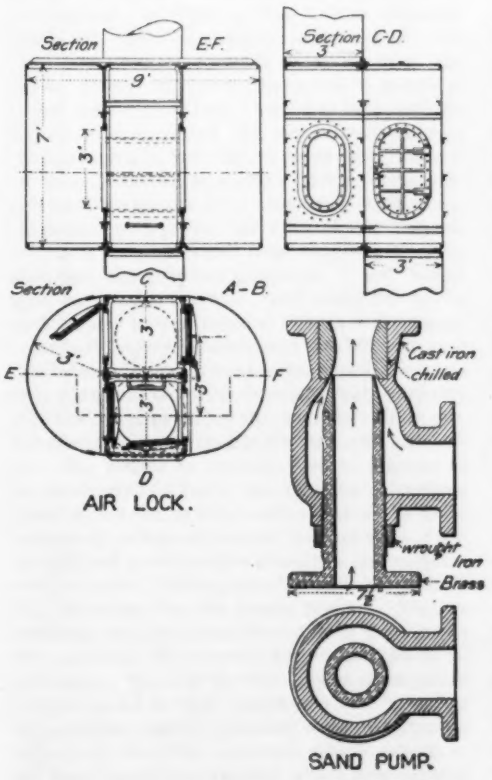
QUADRUPLE-ACTING HYDRAULIC CHARGING CRANE.

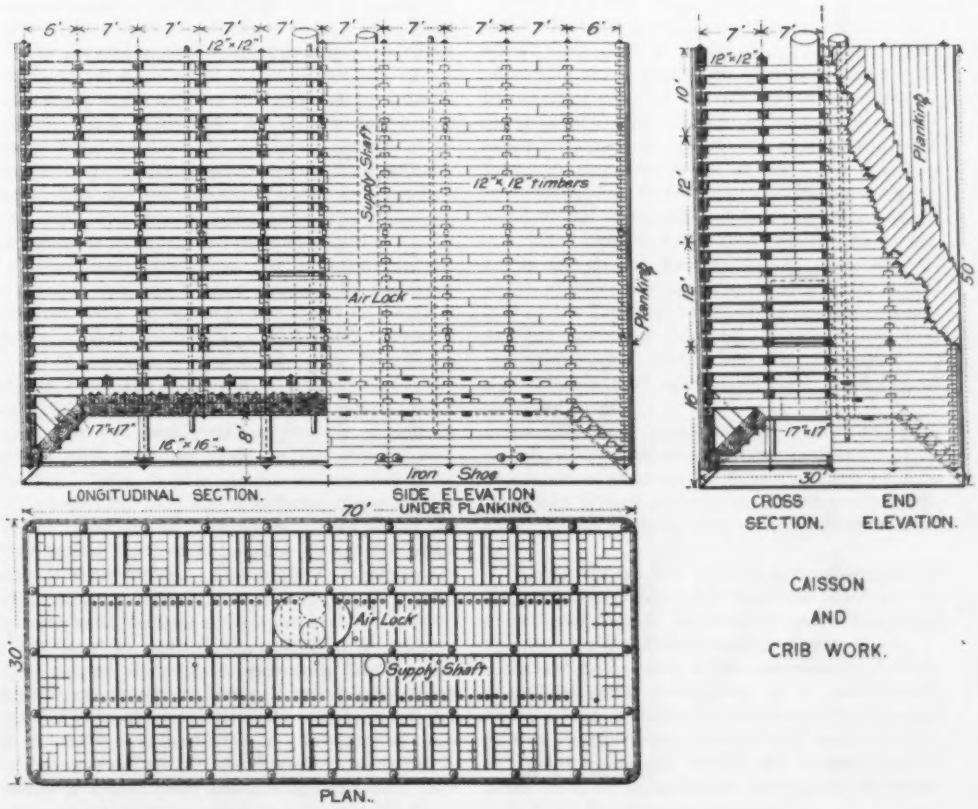






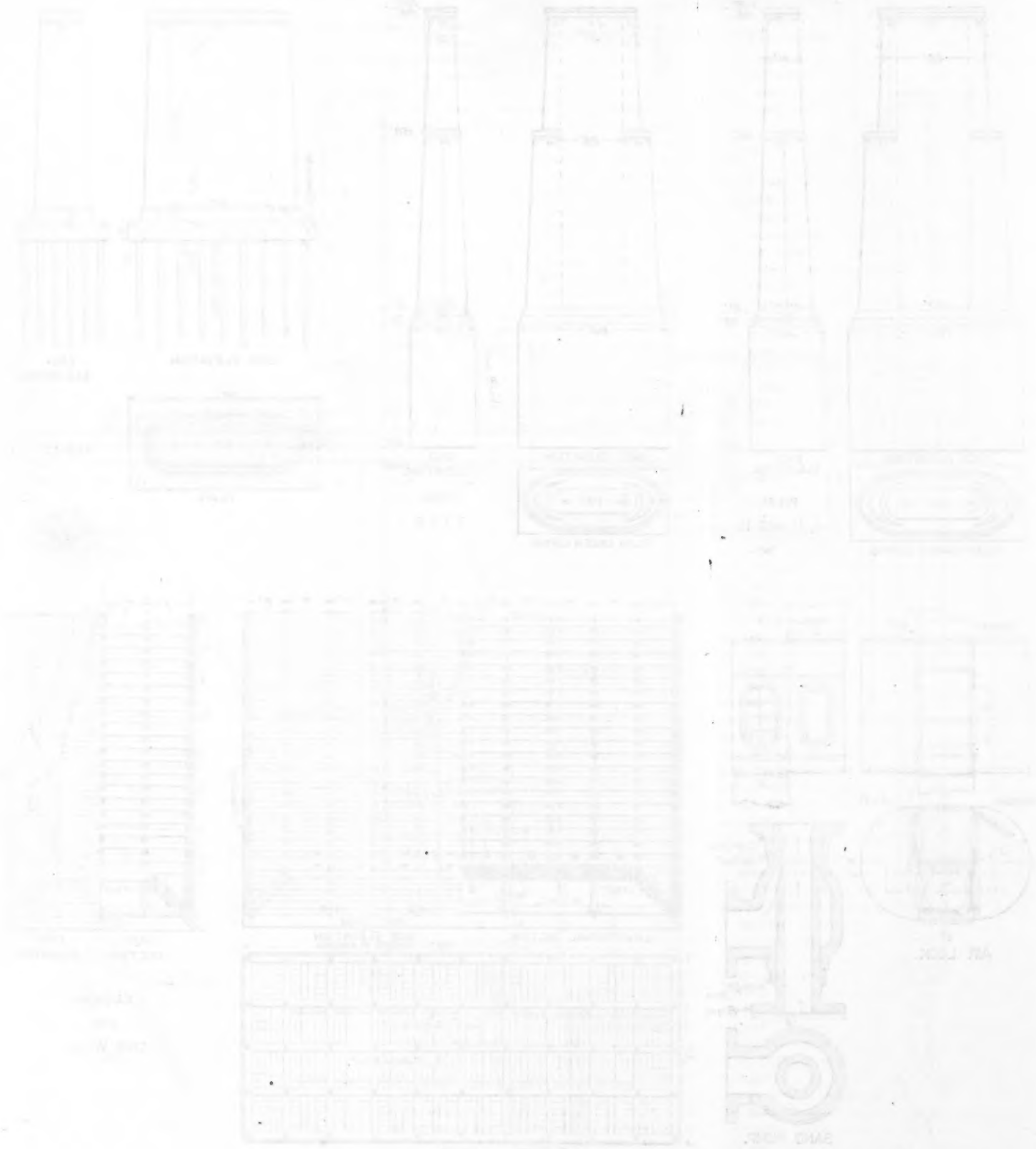






THE SUBSTRUCTURE OF THE CAIRO BRIDGE, ILLINOIS CENTRAL RY.

Geo. S. Morison, Chief Engineer. Union Bridge Co., Contractors. Anderson & Barr, Contractors for Foundations. L. M. Ross, Contractor for Masonry.



estimated to require only $6,532,904(calling 5 fr. = $1), and actually cost, complete, a still less sum, which was divided in purpose as follows:

1. Art building	$1,353,000	12. Water and gas	$120,000
2. Machinery hall	1,503,000	13. Railways	75,000
3. Miscellaneous industries	1,177,000	14. Lavatories	.....
4. Sewers and grading	105,000	15. Restorations	60,000
5. Horticultural exhibition	60,000	16-17. Reserve fund for 1, 2, 3, 4	616,000
6. Agricultural exhibition	120,000	18. Supplementary reserve	19,000
7. Parks and gardens	407,000	19. Service, machinery hall	19,000
8. Offices and police stations	92,000	20. Horticultural shows	13,000
9-11. Roads, fences and bridges	135,000	21. Social economy	15,000
		Total	$5,887,000

Something over $5,000,000 of this was for buildings, but the sums given include all but the running expenses of the exposition. The gross totals of all expenses and receipts of the three Paris expositions were as follows:

	1889.	1878.	1867.
Expenses	$8,300,000	$11,078,000	$5,429,000
Receipts	9,100,000	4,737,000	4,597,000
	Profit.... $800,000	Loss..$6,341,000	Loss..$832,000

A large part of the expenditure for such expositions, however, being that which is required for mere running expenses after the fair is opened, can be met from current receipts; and after making all allowances for the difference in French and American prices, it is difficult to see what the managers of the fair mean by demanding $15,000,000 for it. If their ambition and purpose is to get up a show twice as big as that of Paris, we may be tolerably sure that it will not be more than half as good; and their alleged purpose to divert no less than $2,000,000 to purposes of a cattle show seems an almost grotesque proposition, evincing little comprehension of the true purpose and use of such international expositions.

The Proposed Nicaragua Canal Guarantee.

That the Committee on Foreign Affairs of the Senate should have unanimously recommended a bill providing for a government guarantee of the principal and interest of $100,000,000 of bonds to be issued by a private company engaged in a foreign enterprise was certainly a remarkable phenomenon, in view of the jealous suspicion which all such suggestions excite, as a rule. That committee is generally made up from the oldest, ablest and most conservative members of that conservative body, and is so now, and we may be quite sure that the recommendation was not lightly made, nor made to favor any interests but those of the whole people. Still more remarkable has been the practical unanimity with which the press of both parties has favored the proposition, or at least refrained from opposing it. It is plain that the proposed guarantee is not looked upon as a party question, and while the bill is hardly likely to be reached at this session, it seems to make it highly probable that the bill will pass in substantially its present form, which seems to us to have been carefully drawn to deal equitably with the company and at the same time fully protect the interests of the government and the people. We believe we were the first to suggest, as we did nearly two years ago, that the Nicaragua Canal should not be left to either live or die as an exclusively private enterprise, but that some form of combined governmental guarantee and governmental control ("useless each without the other") was demanded by the public interest. Further reflection has only strengthened us in this conviction, provided only that the bill be equitable in its provisions. We are therefore not at all surprised to learn, as we do from statements which appear authoritative, that the proposed measure emanates exclusively from the committee which reports it, and that the private company which now controls the enterprise, while not unwilling to accept the proposed measure, has had no part in pushing or inspiring it.

Certainly the provisions of the Senate bill seem to insure that the government shall at the worst be no loser, beyond having the canal on its hands at actual cost; and this result only becomes possible in case its cost should prove so much beyond all present estimates that private individuals who had invested in it as a purely private enterprise would lose all they had put in, as the Panama investors have. We do not for a moment believe that this result is possible or threatened; but should it prove so, all will admit that it is better for the people as a whole than for private individuals to find themselves shouldered with such a burden, since the enterprise is surely one of such *prima facie* promise as to demand that an effort be made to construct it. Divested of technicalties, the provisions of the bill are as follows:

The estimated cash cost of the canal being $65,000,000 to $88,000,000, including about 30 per cent. allowance for all contingencies but interest during construction, $100,000,000 20-year 3 per cent. bonds are to be issued, principal and interest guaranteed by the United States. The government is to cause monthly estimates to be made of work done and interest to become due, and the Secretary of the Treasury (who holds the bonds in trust) is to deliver bonds enough monthly to actually cover these estimated expenditures up to the fixed total of $100,000,000. These bonds (no others can be issued) are a first mortgage on the entire property, and should the government be compelled to pay any interest for the company it acquires the rights of foreclosure attaching to the bonds on which there was default of interest. An amount of bonds equal to the actual cash expenditures on the enterprise to date, not exceeding $4,000,000, is to be given to the present company to extinguish all prior claims and expenditures.

Stock to the amount of $100,000,000 is also authorized, $3,000,000 or more of which (enough to make up with the bonds given, $7,000,000) is to be issued at once to the present company as a bonus for their services as promoters, and in lieu of all other stock now outstanding; $6,000,000 of stock goes under the concession to Nicaragua, and $1,500,000 to Costa Rica; $70,000,000 is to be issued to (and voted by) the Secretary of the Treasury, to secure repayment on demand of any sums paid out by the United States under its guarantee, with the right of the United States to purchase all of such stock at par and use the proceeds in redeeming the bonds guaranteed by it. The balance of nearly $20,000,000 is to be held as a reserve fund, to be sold only when the President of the United States finds that the $100,000,000 of bonds will not furnish sufficient money to build the canal, when he can allow it to be sold to raise more money.

Under these conditions, the worst which can happen is that the United States will find itself saddled with an uncompleted canal on which it has expended $100,000,000, and of which it already holds 70 per cent. of the stock, with foreclosure rights upon the rest of it; in other words, the government will, as a last resort, have to build and own the canal itself, paying for it only its actual cost, with *no* profit to the original projectors. Even in this case the government (*i. e.*, the people) can only lose if both the direct and indirect value of the canal to the United States, for both military and civil purposes, is not worth the cost of construction. The original projectors lose all interest in or profit from the enterprise beyond getting back the face of their original investment.

On the other hand, if the enterprise is successfully carried through at something like the estimated cost, it may be either (1) built on the $100,000,000 of bonds only (which are likely to sell for $110,000,000 to $115,000,000) or (2) require the sale of the reserved $20,000,000 of stock in addition, in either of which cases the government may elect either to (*a*) not buy or (*b*) to buy the $70,000,000 of stock which it holds in trust.

In case 1*a* (building the canal on the bonds and the government not buying the stock it holds), there will be only some $11,000,000 of stock out, of which the original projectors (the managing company) may hold some $3,500,000, say 33 per cent., and all the profits of the enterprise will accrue to these stockholders beyond the $3,000,000 per year required to pay interest on the bonded debt. In case 2*a*, the same conditions will obtain, except that there may be $30,000,000 of stock out, of which the original projectors will then hold only 11⅓ per cent. Obviously it will be greatly to the interest of the managing company to build the canal on the bonds, without selling this reserve of stock, if possible.

Should the government exercise its prerogative to buy the reserved $70,000,000 of stock at par (case *b*), this $70,000,000 will in effect be paid in cash into the treasury of the company, whether nominally used to redeem the bonds or not; and according to the amount of stock out, 87½ per cent. (case 1*b* or 70 per cent. (case 2*b*) of the amount so paid in by the government will go back to it, and 4⅔ or 3½ per cent. of it respectively ($3,062,500 or $2,450,000) will go to the original projectors by right of their stock interest, which will then be only 4⅔ or 3½ per cent. of the total stock outstanding. In view of the fact that the lowest probable net revenue of the canal after it has been opened for two or three years is $8,000,000 to $10,000,000, it will be seen to be greatly for the interest of the managing company (1) that the government should *not* buy the $70,000,000 of stock which it holds in chancery and has an option on, and (2) that the canal should be built for the lowest possible cost. This seems to leave small ground for fears that a guarantee of this kind would lead to intrigues to force the government into an investment which was not for its interest, or that the existence of the guarantee would lead to extravagance in expenditures. The management of the enterprise is still left entirely in the hands of a private company, which is well, but the terms are so arranged that it is greatly *for their interest* to build the canal as quickly as possible, for the least money possible and without involving the government in any permanent investment.

Now, what does the government (*i. e.*, the people) gain by incurring this limited amount of responsibility? Its gain is threefold. First and most important, the government obtains absolute control of the future of the enterprise, by which it can prevent it from falling under control of any foreign nation or syndicate to the injury of American interests; while at the same time the government has no responsibility for the management of the enterprise unless it choses to assume it. This control is insured by the fact that $70,000,000 of the $100,000,000 of stock is to be withheld from sale and deposited with the Secretary of the Treasury, *with voting powers thereon*, and an option of purchase at par which does not expire until 1911, while the government is also authorized to appoint outright 6 of the 15 directors directly.

Secondly, the guarantee is quite certain to largely reduce both the cost of the work and the rate of interest on that cost, so that the rates of tolls necessary to earn interest on its cost will be less than half as high as they would otherwise need to be.

Thirdly, the control granted in consideration of the guarantee ensures that the tolls shall not be kept higher than is required to pay a reasonable interest on the actual cost of the works.

On the other hand, if the construction be left to unaided private enterprise, it is quite certain that a private company which has carried through so vast an enterprise unaided will keep the tolls at a point which will return the largest possible profit to them, regardless of how great the return may be on the actual investment.

To this policy no reasonable objection could be made, moreover. Private individuals who risk the loss of a vast investment by war, pestilence, corporate rascality, financial panic, or unexpected

construction difficulties, will have a perfect right to treat the canal when they have finished it as a mere enterprise for private profit, and so get all out of it they can. And this return may easily become very large. It is almost certain that the traffic of the Nicaragua Canal will speedily become larger than that of the Suez Canal, for the reason (1) that it connects more progressive and more rapidly growing communities, and (2) that in addition to all the sources of traffic which the Suez Canal has, in saving a long voyage around the peninsulas of Africa and South America, its chief traffic is likely to come from a source which has no real parallel in the development of Suez Canal traffic, viz., in making possible a vast exchange of heavy and bulky products between the Atlantic and Pacific coasts of the United States, which now hardly exists at all because of the cost of transit. The timber traffic alone will speedily become an immense one, and the traffic in coal, ores and other minerals and grains is also likely to be very large. This may be better realized by considering what a vast traffic has developed on the great lakes within the last few years, which was thus set forth by the late Secretary WINDOM in the speech of last week which preceded his sudden death:

> The tonnage which passed through the Detroit River alone during the 234 days of navigation in 1889 exceeded by 2,468,127 tons the entire British and foreign tonnage which entered and cleared at London and Liverpool that year in the foreign and coastwise trade.
>
> The freight which passed through the St. Mary's Falls Canal in 1890 exceeded by 2,257,876 tons the entire tonnage of all nations which passed through the Suez Canal in 1889. The freight carried on railroads of the United States in 1890 exceeded by over 36,000,000 tons the aggregate carried on all the railroads of the United Kingdom, Germany, France and Russia in 1889. Commodities are interchanged among our own people with greater facility and at cheaper rates (distance being considered) than in any other country on earth.

Taking all things into consideration, a tonnage of 10,000,000 per year seems no more improbable for the Nicaragua Canal ten years after it is opened, than would have seemed to the present Suez tonnage of over 7,000,000 when that canal was opened; and a tonnage of 10,000,000 per year at $2.50 per ton would return an income of $25,000,000 per year, of which $20,000,000 at least would be clear profit, which might prove to be enough to pay 20 or 25 per cent. on the actual cost. We must not be understood to predict any such revenue, but it is certainly among the possibilities, and if the entire construction be left to private enterprise, such a return would certainly be pocketed by the stockholders without a qualm of conscience, and continued as long as possible.

The decisive point in favor of governmental control and aid, however, seems to be that the work, although geographically foreign to our country, is in its essential nature a great work of internal improvement for connecting our eastern and western sea coasts, which will be so much more favorable than any other route as to inevitably tend to become a great monopoly controlled for revenue only if left in private hands, while otherwise permitting of much cheaper transportation than now exists. Therefore, it should, if possible, be assured early and cheap construction and control in the interest of the people. If this can be effectively insured without involving the government in any serious responsibilities or chance of loss, why should it not be done? We may look with little favor on direct subsidies of private enterprises of any kind, but when great public ends can be secured simply by guaranteeing interest on the actual cost of an urgently needed work, so great as to be far beyond the limits of ordinary private enterprises, and hence at an inevitable disadvantage in seeking to secure private capital on reasonable terms, we fail to see why it is not good sense and good politics to give such guarantee.

For suppose some guarantee of this kind is refused; what will it mean? Plainly that the company now controlling the enterprise must raise the necessary $100,000,000 where and how they can. Where (if at all) can a private company raise $100,000,000 most quickly and cheaply? Unquestionably in London or in its financial dependencies on the Continent. What do rational men who put $100,000,000 cash into any enterprise always insist upon? Practical control of the enterprise *and* ground-floor prices. Having got such control and prices, what are they likely to do? Sell out to any one who offers a handsome advance on the cost of their securities. Who is most likely to offer such a price? This question we will answer by asking another, in Yankee fashion—What became of the controlling fraction of the stock of the Suez Canal?

Rules of Interchange for Cars with M. C. B. Couplers.

A recent order issued by the New York Central Railroad, relative to cars fitted with M. C. B. couplers, requires inspectors at interchange points to refuse such cars in case there is any breakage of the coupler knuckle. This order has been the subject of some criticism on the part of friends of the M. C. B. coupler, and considerable praise by its enemies. It has been generally taken for granted that the order was issued to injure the popularity of the M. C. B. coupler. At the recent meeting of the New England Railroad Club it seemed to be generally understood that this was the case; and the order was lauded accordingly.

We can say authoritatively that this is a wrong understanding of the New York Central's position with regard to the M. C. B. coupler. Until this order was issued it has been the practice to accept M. C. B. coupler cars with the knuckles in any condition, so long as the draw-bar was all right, for such a car can be coupled with the link and pin and is therefore "safe to run" under the present rules of interchange. Of course a "defect card" is attached, but the car may run for months before the broken knuckle is replaced, and during that time all benefit of the use of the automatic coupling is lost. Very likely such a car may be sent into New England, and, running around over the numerous short roads in that section for a few weeks, it may be counted as thirty or forty different cars and may furnish the text for as many sermons upon the breakages of M. C. B. couplers.

The number of cars equipped with M. C. B. couplers running on the New York Central is now large enough to make it of considerable importance that all cars fitted with M. C. B. couplers received in interchange shall have their automatic couplers in working order. The word "safe" as used in the interchange rules is a relative term. If a car is fitted with automatic couplers it may fairly be claimed that such a car is not "safe to run" if the coupling with a car similarly fitted has to be made with the link and pin in the ordinary and undeniably dangerous way. The interchange rules now provide that an air brake car may be refused if hose or couplings are gone, necessitating use of the hand brake; and there seems equal reason in demanding that the automatic coupling shall be in working order.

The New York Central has now more cars fitted with M. C. B. couplers than any other company, except, perhaps, the Pennsylvania. Having about a quarter of a million dollars invested in M. C. B. couplers, it is, of course, for the manifest interest of the company to forward their general introduction as fast as possible. The order above issued is expected by Mr. BUCHANAN to help the coupler reform, rather than hinder it.

The enforcement of this order is likely also to help the M. C. B. coupler by driving out of the field manufacturers who persist in putting weak and unreliable couplers on the market. No one, not even the manufacturers themselves, deny that the M. C. B. couplers which were first put on the market by some of the minor companies have proved sadly defective in service, and the breakages have been large. Placing couplers of this sort in service injures the popularity of the M. C. B. type and tends to increase accidents. Insisting that defective knuckles shall cause a car's rejection is likely to bring railway managers who have been experimenting with cheap types of coupler to realize that in this case the best is the cheapest.

That the real purpose of the New York Central's order is beginning to be better understood is evidenced by the action of the Central Railroad Club, which, at its meeting on Jan. 28, voted that cars with defective knuckles should be refused in interchange. It was also voted that for certain specified defects of the M. C. B. draw-bar, cars should be received with a defect card attached. It is quite likely that the subject will be brought up at the next meeting of the Master Car Builders' Association, and a revision of the rules of interchange will be asked for.

The only question as to the wisdom of the policy of refusing all defective knuckles in interchange is whether the rule may not be construed to stop cars with knuckles so slightly chipped as to be practically uninjured. This may occur in a few cases; but where to draw the line and say how much chipping shall cause the rejection of the car is so difficult a matter that it has been deemed best to stop a few cars which might be safely passed, rather than put upon inspectors the duty of drawing the line between a chipping which weakens the knuckle and one which may be ignored. In practice it may be found that the matter will regulate itself; the inspector will be likely to overlook defects so small that they should be passed.

There are some other matters in connection with the interchange of cars fitted with M. C. B. couplers on which discussion is needed. The increase in the number of styles of M. C. B. coupler on the market makes considerable trouble in inspecting and repairing cars. A stock of knuckles for each style in use on any road has to be kept at each repair shop; and if these new candidates for favor drop out of sight, the stock on hand at various places is a loss.

If the companies which put out new designs of the M. C. B. coupler really wish to get on the right side of the railway mechanical officers, let them attach a spare knuckle to each car fitted out by them. It cannot be expected that every railway in the country will lay in a new stock of knuckles for each new style of coupler put in service.

Again, the use of a cheaper coupler in repairs than the one broken is rightly objected to. It has been stated recently that certain cars have been fitted by foreign roads with cast-iron knuckles in place of malleable iron knuckles which had been broken. It seems impossible that any railway should do so dishonest a thing, and we doubt the correctness of the report. The practice of permitting railways to replace broken knuckles with knuckles made by other than the regular manufacturer, however, opens the way to abuses of this sort.

In conclusion it may be said that the New York Central's order has been construed by some as an indication that M. C. B. coupler breakages were multiplying on that road and becoming very serious. Such, however, is not the case. Exact records of coupler breakages are being kept, and the average cost of maintenance per car is proving astonishingly small.

CORRESPONDENCE.

Estimating Overhaul of Earthwork.

NEW YORK, Jan. 31, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In relation to the article on "Estimating Overhaul in Earthwork by means of the profile of quantities," published in the current issue of ENGINEERING NEWS, I would state that the method was in extensive use on the South Pennsylvania R. R. in 1883-1885, on preliminary and location surveys, and also, later, during construction, for monthly

estimates. Its flexible qualities, and its many uses, will suggest themselves in adapting mountain grade lines to the best ground (especially where the side slopes are very steep, and the actual profile of the center line shows so little of the real amount and location of the material to be moved), for arranging the distribution of the quantities to the greatest advantage as to overhaul, waste, or borrow, and the fixing of section posts. In rock work or where any mixed material is encountered, care must be exercised to allow for the proper shrinkage and swelling of the several materials, and the percentage so obtained must be embodied in the original algebraic summation of quantity before the ordinates are plotted on the profile or cross-section paper. This graphic method was mentioned in a paper published in the Proceedings of Engineers' Club of Philadelphia, Vol. IV., No. 2, May, 1884, by EDWARD THIANGE and J. M. RÜDIGER, Jr. C. W. S.

"The Railway of Evolution."

BRIDGETON, N. J., Jan. 29, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Noticing in your issue of Jan. 10 a criticism on my railway article in the January *Forum*, I write to say that I think if you will examine it more carefully you will find that I had not the intention you credit me with, of finding fault with the designers of our railway machinery, nor with its management by the executive officers in charge thereof. I have therein written nothing criticising our railway personnel, even by implication, unless possibly the title might be so construed. This was originally written "The Railway of Evolution" and was accidentally changed. It was not intended, however, to be "read by title" only.

The creators of our railway system, from GEORGE STEPHENSON onward, deserves the highest credit for overcoming the almost insuperable difficulties incident to its development. As stated in my article, the results are magnificent, especially in view of the limited amount of capital which has been available. The article in question was not intended as anything more than an analysis of the system in general; together with a prophecy of what may come in future years, with such entirely different methods as are likely to become practicable through the expenditures of vast capital, and by the use of such radically different methods of propulsion as electricity will probably give us, if it replaces steam locomotives.

As is clearly stated, many of the remedies suggested cannot to any very great extent be applied to our present railways, but must be used in developing some entirely new system which, I venture to predict, will, a few years hence, not seem so wonderful to all of us as will the fact that the world was content to go on thus long with the amount of danger that now exists, and with the dragging about of the enormous dead weight which you seem to regard so lightly—in some cases as much as five or six tons to a passenger, with a half-loaded train.

After all, an imaginary future development of any industry in a particular direction is merely a matter of opinion. Time alone will show who is right, those who base their ideas wholly upon their practical knowledge and experience with a system already in use, or those who speculate somewhat in "futures," basing their ideas upon certain scientific analogies which are already existing facts. I am very willing to let the essay in question stand as a prophecy. OBERLIN SMITH.

[The only specific statement to which our correspondent takes exception is "the enormous dead weight" question. On that his letter has suggested to us that a few words might be said to advantage, and we shall do so in a following issue.—ED. ENG. NEWS.]

The Overloading of Freight Cars.

INDIANAPOLIS, Ind., Jan. 31, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In answer to our communication in your issue of Jan. 10 you say:

> The actual records of weighing quoted are of much interest. They show a saving of freight collected of $2.48 per car from weighing 7% of the cars. We may not unreasonably assume, however, that this 7% included about all of the cars which there was much chance of finding overloaded.

If you were right in this proposition the Wanamaker Car Scale Co. would not be engaged in the business of manufacturing scales to be attached to freight cars, and, as you say, "no prudent managers would go into an investment of this kind."

The fact is, the amount of revenue gained per car on the 7% of the cars weighed represents the average overload of all. Many of the cars composing the remaining 93% of the cars passing over the roads comprising this division were weighed by other division weighing associations with practically the same results as shown by the report of the division from which we have quoted.

From the best information we can obtain we learn that it is impossible to overload cars that are loaded with a certain class of freight, viz., furniture, carriages, buggies, hay, etc., and we are informed that cars containing such freight are the only cars that are not weighed.

Your manner of arriving at the result of the benefits to be derived from the use of the Wanamaker scale is novel and ingenious, and if started on the right basis demonstrates fairly the facts that are desired to be ascertained. We will take your proposition and figure it out on your plan, but on the basis stated, with the 7% of the cars weighed representing the average overload of all, except those loaded with furniture, etc., which we will estimate at 25% of all. With an average weighing of 100 times per year, instead of 165, which is all that could be expected on the average haul and mileage, the result would be:

Revenue gained on 100 cars at $2.48, weighed 100 times..... =	$24,800
Less 25% cars not overloaded, $6,200 + $370 interest + $1,000, 10% of cost, + $1,500, wear and tear, =	9,070
Total net gain in revenue effected.....	$15,730
Cost of 100 scales at $100 each.....	10,000
Net gain over cost, interest and maintenance..	$5,730

We have delayed forwarding this reply to you, as we desire to know that we were right in our statement that the overload of the cars weighed, represented an average overload of all cars. This we have now ascertained to our entire satisfaction. Cars having the appearance of being overloaded are not sorted out to be weighed, as you implied was the case, but on the contrary, it is the intention of these different weighing associations to weigh *all* cars to the extent that it is possible for them to do so; but the limit of valuable terminal facilities at railroad centers where scales are located, and the fact that the use of locomotives are required to weigh on track scales, makes it impossible to weigh them all.

The figures and calculations made on a basis of the average overloading of cars taken from the reports of the various weighing associations, each of them weighing only a small percent of all cars, and all of their weighings not more than 50% of all cars hauled, are only valuable to approximate the amount of revenue lost to railroads, even while they are under the great expense and loss of time incurred by weighing cars by the use of locomotives and track scales, and while we do not think that the revenue to be gained by the use of our scale will be as large as the figures show, we do know and have arrived at the knowledge after careful inquiry and investigation from a business standpoint, and from years of experience in the railroad service, that fully 10% of bulk freight that is hauled in car loads is hauled by railroads for nothing. With the Wanamaker Scale attached to cars, railroads can bill out and collect for every pound of freight they haul without incurring the great expense and delay incident to weighing on track scales.

THE WANAMAKER CAR SCALE CO.

Notes and Queries.

A. McL. H., of Denver, Col., asks the following questions, which we refer to our readers: Are there any recorded tests of the tensile strength of wrought iron pipes from ⅛ in. to 3 ins. inner diameter? Are aluminum steel rods, ⅜ to ⅞ in. diameter, to be had in the market, and have tests been made and recorded of the tensile strength of such rods?

Electric Power for Tunnel Traffic.

The subject of a choice of some power other than steam for use in tunnels will soon be thrust upon the Rapid Transit Commission of this city. Just as the success of the Greathead system of tunneling under the Thames has doubtless given the present "boom" to tunnel projects for rapid transit in this city, so the electric locomotives used on that same South London subway have very practical y demonstrated the value of this agent for use in tunnels. In this connec ion the following items from the inaugural address of Mr. JOHN WEST, President of the Manchester Association of Engineers, are interesting, though, of course, any plant for the length of road and speed proposed for the New York tunnels would have to far exceed the power and capacity here described. In speaking of the South London plant, Mr. WEST says:

> The power is generated in the first place by the combustion of coal in a range of six Lancashire boilers, working at 140 lbs. per sq. in. and fed by mechanical stokers. Each boiler is 7 ft. in diameter by 28 ft. long. The steam passes from these boilers to three vertical compound engines, having cylinders 17 ins. and 27 ins. in diameter by 27 ins. stroke. The two cylinders of each engine are fitted with automatic expansion gear, the governor being of the Hartnell type. The fly wheels are 14 ft. diameter by 23 ins. wide, turned to receive inch belting. The engines run at 100 revolutions per minute, at which speed they indicate 175 HP. each.
>
> The exhaust steam is all used for heating the feed water in the large water heaters. The dynamos for converting the power of the engines into electric energy are of the Edison-Hopkinson type (known in this country simply as the Edison type), giving an output of 475 volts and 475 amperes, at about 500 revolutions, and can be used as 'shunt' or 'compound,' as desired. The electrical efficiency is 90%. The machines are very massive, the yokes alone weighing about 3 tons each, the complete dynamos being of nearly 15 tons weight. The efficiency of the whole combination of engine, belt and dynamo is over 75%.
>
> There are at present 14 locomotives on the line, each of 100 HP. and available for a speed of 25 miles per hour. Each locomotive has two axles and each axle carries the armature of an electric motor, so that there are two motors and no gearing on each locomotive, but only one armature can be used at a time. The magnets of the motors are subtended from the frame of the locomotive and fitted with bearings on the axle. They are also fitted with switches for stopping, starting, and reversing. The Westinghouse compressed air brake is applied to the four wheels of the locomotive, the air being contained in a receiver, to be replenished at the engine room at the end of each double journey.
>
> The current is taken from the generating dynamos by main cables consisting of 61 wires, 14 gage, and insulated and sheathed in lead and carried along the side of the tunnel. Connections are made at intervals between the main cable and a light steel channel rail supported between the railway metals on glass insulators attached to the sleepers and forming the conductor from which the locomotives take their current by collectors carried on the buffer-bearing at each end. The steepest gradient against the load is about one in thirty. In such circumstances as these underground railways present there seems almost a limitless field for the use of electricity as well as for traction on tramways, overhead railways, and everywhere else where the fouling of the air by steam and smoke is likely to be detrimental to the health of the people.

Rapid Transit for New York City.

The Stewart rapid transit bill has been signed by Governor HILL and is now a law that opens the way, we all hope, to some speedy and satisfactory method of settling a long discussed problem.

Briefly abstracted, this bill continues the present rapid transit commission, and gives it power to determine whether rapid transit is necessary; by what routes and methods it is to be obtained; provides for commissioners to condemn property, and specifies that no elevated structure shall be built on Broadway south of 33rd St., or on Madision avenue.

Any route selected requires the approval of the Board of Aldermen or the Mayor; or in case the Mayor dissents, a two-third vote of the aldermen. Section 7 provides for selling the franchise at public auction; and a following section provides for a resale after one year if the first purchaser has failed to use it.

Engineers are to be employed by the Commission, and the expenses of the Commission are to be paid out of the city treasury. If a corporation is formed to exercise any franchise conferred under this act, each corporation so formed must have 13 directors, elected annually; articles of incorporation must be filed with the Secretary of State, and there must be paid to the State a tax of ⅛ of 1% of the total stock.

The commissioners may make changes in the route after the franchise has been transferred to a corporation. The corporation would have power to cross or unite its road with any other existing road; to convey passengers and property by any means of traction except animals; to tunnel the streets and to borrow money.

Section 32 gives power to the present elevated road, by a concurrent vote of all the members of the Commission, to lay an additional track on any of its lines and also to provide terminal facilities.

Underground Telegraphs.

The underground system of telegraphs of the German Empire, says *Industries*, has a total length of 3,000 miles, and has cost $10,500,000, or about $3,000 per mile. There are 16 lines—viz., Berlin-Kiel, *via* Hamburg; Hamburg-Cuxhaven, *via* Harburg; Harburg-Greetsiel, *via* Bremen, Oldenburg, and Emden (Greetsiel being the terminus of the German-American cable); Bremen-Bremerhaven; Oldenburg-Wilhelmshafen; Berlin-Metz, via Magdeburg, Hanover, Wesel, Cologne, Coblence, and Thionville, with branches to Barmen, Aix-la-Chapelle, and Frankfort-on-the-Main; Berlin-Metz (a second line, via Halle, Cassell, Frankfort, Strasburg and Sarreguemines; Halle-Leipsic; Strasburg-Baden, via Neufbrisach; Berlin-Dirchau, via Münchenberg, Posen, Thorn and Graudenz; Berlin-Elydkunen, via Stettin, Colberg, Stolpe, Danzig and Dirchau; Berlin-Breslau and the Austro-Russian frontier, via Münchenberg and Glogau; Berlin-Dresden, via Cottbus; Stuttgart-Carlsruhe; Munich-Hof and Hof-Dresden. The last two are still under construction.

Notes on English Railways.

The following articles are compiled mainly from notes made during a stay of some months in England last year. While they are necessarily of a rather general character, they will contain many details of railway practice not to be found in any publication, and as they will represent English railways as they now are, much of the information will be new and interesting to American readers. The notes and observations were made during the course of various railway journeys, visits to stations and works, interviews with railway officers, etc., and have been put together and elaborated to form connected articles.*

GREAT NORTHERN RAILWAY.

This is one of the most important trunk lines, and has a very large through traffic over connecting lines, although its own main line from London to York is only 188 miles long. It is one of the leading routes (known as the East Coast Line), with the fastest trains, to the north of England and Scotland; its Scotch expresses are among the notable trains of English railways. The system comprises about 900 miles, and the principal cities upon it include Manchester, Sheffield, Grantham, Doncaster (where are located the company's locomotive works), Nottingham, Bradford, York, Leeds, Grimsby, Hull, etc. There are several long grades of 0.5%.

Track.—This road is laid with bull-headed steel rails, weighing 82 lbs. per yd., carried in cast iron chairs which are fastened to cross-ties 8 ft. 11 ins. long, 10 ins. wide, and 5 ins. thick. In some cases there are a spike and a trenail on the outer side of each chair, and a spike on the inner side; in other cases there is a spike on each side. The wooden keys which secure the rails in the chairs are driven on the outer side of the track. The rails are laid with square joints, and both supported and suspended joints are used. In the former case the rail ends rest on a special chair on the joint tie, which chair has a jaw only on the outer side; the rails are spliced by two plain splice bars 18 ins. long, with four bolts, the two middle bolts passing through the jaw of the chair as well as through the splice bars and rail. There are 13 ties to a rail length of 30 ft., including both joint ties; the joint and shoulder ties are spaced 1 ft. 9¼ ins. c. to c., and the intermediate ties 2 ft. 7¾ ins. This arrangement makes an easy and comparatively quiet riding track. The suspended joints are spliced with two plain splice bars and four bolts. The nuts of track bolts are on the inner side of the rails. Gravel and burnt clay are used for ballast, and near London large quantities of red clay were being burnt for this purpose. On main tracks the ballast generally covers the ties; it is nearly level with the under side of the rail heads, and rises slightly to the middle and outside of the track. Cross drains in the ballast are provided under the ends and middle of the rails; in some cases there are two intermediate drains between those at the joints. Some bridges have the floors of arched iron plates, without any ballast; the rail chairs are fastened to longitudinal timbers, and no guard rails are used. On some short deck bridges the girders form a trough for the rails. Near Trent there is a grade crossing of two double track lines.

Wooden posts are placed to mark every quarter of a mile. They are painted white and have block figures painted in black. The ¼, ½, and ¾ mile posts are of triangular section, with an enlarged head of the same form; the back is parallel with the track, so that a face is presented to trains in both directions.

Semaphore signals are used, but the blades are pivoted at the middle, and stand vertical when indicating "track clear." This plan was adopted after an accident had been caused by the weight of snow on a semaphore blade having lowered it to the "track clear" position. As usual in England, the face of the blade is painted red, with a white square near the outer end; the back is painted white, with a black square. Notched or "swallow-tail" blades are used for distant signals. A large number of iron lattice signal posts are used, and on some of the taller posts the lamps are hoisted and lowered by a chain which passes round a pulley or winch fastened to the post a few feet from the ground and worked by a crank. The engineer has been desirous of obtaining a specially distinctive distant signal, as engine drivers are allowed to pass these, when at danger, at a slow speed, but are not allowed to pass home signals, when at danger, under any conditions. The Koyl parabolic semaphore signal has been under consideration for this purpose. Great care has been taken in obtaining the glass for signal lamp spectacles, and very clear colored glasses have been selected. Red is used for the danger signal, green for track clear; a white light is no signal, and must be considered as indicating danger. The back lights are white when the signal is at the danger position, and green when it indicates track clear. The same system of colors is used in hand signaling at yards, etc. Formerly both green and blue were used for the "track clear" signal, the former being for fast and the latter for slow lines, but green is now uniformly used.

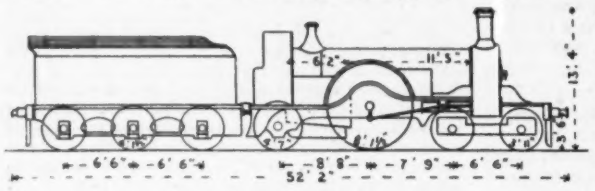


Fig. 1. Express Locomotive; Great Northern Ry., England.

Locomotives.—The finest engines on this road are the celebrated express engines, with outside cylinders and a single pair of large driving wheels. This class of engine, an outline diagram of which is given in Fig. 1, was designed in 1870 by Mr. PATRICK STIRLING, Locomotive Superintendent, and is still adhered to, with a very few minor modifications, for heavy express service. The leading dimensions of these engines are as follows: Cylinders, 18×28 ins.; driving wheels, 8 ft. 1½ ins. diameter; truck wheels, 3 ft. 11 ins. diameter; trailing wheels, 4 ft. 7½ ins. diameter; the center of the truck pin is 3 ft. 6 ins. from the leading axle, and 3 ft. from the trailing axle of the truck. The boiler is 48 ins. diameter, and there are 174 tubes 1¾ ins. outside diameter and 11 ft. 9 ins. long. Heating surface: tubes, 936 sq. ft.; fire-box, 109 sq. ft.; total, 1,045 sq. ft. Grate area, 17¾ sq. ft. Boiler pressure, 140 lbs. In working order the engine weighs 101,136 lbs., distributed as follows: 39,312 lbs. on the truck, 38,080 lbs. on the driving wheels, 23,744 lbs. on the trailing wheels. The total weight of engine and tender is 156,800 lbs. These engines are noted for the high rates of speed which they make in everyday service. There are also some inside cylinder express engines with a single pair of driving wheels, 7 ft. 6 ins. diameter, and a single pair of leading and trailing wheels. Neither of these classes of engines are fitted with domes. Like the majority of English roads, this line has a number of tank engines, including some large stocky-looking side tank engines, with four coupled driving wheels under the boiler, and a four-wheel trailing truck under the bunker. Many of these engines are used for suburban service and on parts of the underground railway of London; for this latter service they are arranged to turn the exhaust into the tanks when running in the tunnels, and vent pipes leading over to the front of the middle of the cab are provided to carry off the steam when the water in the tanks becomes hot; these engines have large, roomy cabs built of iron, and entirely covered in, with the exception of an opening at each side of the foot-plate. A number of through trains make the run of 105 miles between London and Grantham without a stop; the engines of these trains are provided with very large tenders, track tanks not being in use on this line. The engines have the boiler, wheels, cab, etc., painted a light bright yellowish green, picked out with black and white striping; the frames are a dark chocolate brown; the safety valve casing is of brass, and the smokebox and smokestack are black.

Rolling Stock.—This road has fairly good passenger equipment, and its cars are as a rule well upholstered and kept in good condition. Some of the cars are carried on trucks, others on two or three rigid axles; some have two axles at each end, but not arranged in a truck frame. Oil boxes are very generally used instead of grease boxes. Several of the newer cars have the high, rounded, turtle-back roof (which is used to some extent in this country), instead of the old form of roof built with a flat curve. Among the special equipment may be mentioned a long dining car, carried on six-wheel trucks. The upholstering is generally in dark green patterned carpeting, with green window curtains. Close-woven gray horse hair is used for the smoking compartments. The Pintsch compressed gas system is much used for lighting, and many of the newer cars have a small exhaust fan ventilator in each side of each compartment. The company has conducted extensive experiments with different systems of lighting, including electricity, and has now adopted compressed gas and oil. Trains running more than 20 miles without stopping are fitted with a communication cord between the engine and rear guard's van, the cord being carried through small rings or pulleys under the eaves of the roof; there is frequently a cord on both sides, but the one on the right hand, or "off" side, is the only one for use. The cars are not painted on the outside, but the natural wood, which is of a dark yellowish brown color, is rubbed down and varnished. The letters and numbers are gilt, shaded in blue, and the panels are edged with gilt.

On the long run from Aberdeen to London, by the East Coast line, about 525 miles (Aberdeen to Edinburgh and Berwick, North British Ry.; Berwick to York, Northeastern Ry.; York to London, Great Northern Ry.) there are used some very comfortable third class saloon cars of the Great Northern Ry. The running gear consists of three rigid axles, with oil boxes. The general arrangement of one of these cars is shown in Fig. 2, and very much resembles that of the Mann boudoir cars. It was

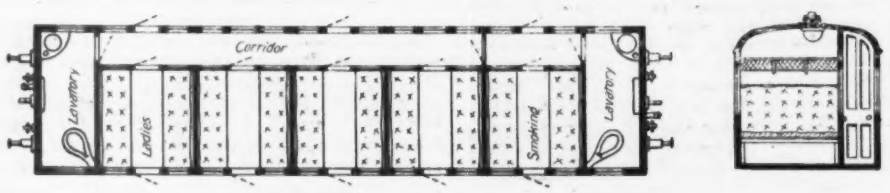


Fig. 2. Third Class Saloon Car; Great Northern Ry., England.

divided into five compartments and had a lavatory at each end; in this particular case, however, water and towels had been forgotten, so the accommodations were not as good as they should have been. The compartments were shut off from the corridor by a partition, and a door was fitted in the corridor to shut off the smoking compartment. The arrangement of the lavatories is much superior to that generally used in English cars, by which two separate lavatories are placed between two passenger compartments; a door in each compartment opens directly into the lavatory, which is not only a very unpleasant arrangement, but a very embarrassing one with ladies in the compartment. The car had a turtle-back roof, fan ventilators (torpedo air extractor) in sides and roof, and the Pintsch light. The floor was covered with oil cloth. The seats and high padded backs were upholstered in a dark green carpet cloth with a small subdued pattern in black and red, fastened with red buttons. The smoking compartment was upholstered in gray horse hair. The carpet cloth is a better looking and better wearing material than the plush generally used in this country; it is pleasing

* More detailed information in regard to track will be found in Mr. E. E. R. TRATMAN'S paper on "English Railway Track" (Trans. Am. Soc. C. E., June, 1888), of which an abstract was published in ENGINEERING NEWS, July 7, 1888.

to the sight and touch, is durable, does not show wear, and is easily brushed and cleaned. The English system of spring cushioned seats with the backs padded to the height of the passengers' heads, which is now quite generally used in even the third class cars, the padding being shaped to the general form of the body and set out by springs so as to accommodate itself to the outlines of different bodies, is much more comfortable than the average style of seat or chair in American cars. The doors had sliding sashes dropping down into the lower panel of the door and fitted with a non-rattling spring sill, but the other windows were fixed; the partition doors had a sliding sash in the upper part, which was held at any height desired by a spring bolt fitting into holes in the frame of the lower sash. All the inner doors were fitted with a patent spring latch, opened by pulling or pushing the knob. The windows were all fitted with spring roller blinds, which could be fastened in different positions by slipping the ends of the rod at the bottom into notches in wooden guides. This arrangement is in use on a number of cars, and is used also in this country. The partition, door and window frames, etc., and part of the sides were of polished wood; the roof was painted white and the upper part of the sides and ends buff, with a little blue striping. Labels printed in red, black and gold, advertising the company's hotels, were pasted in each compartment. The inner side of the doors was paneled in green. Sliding gridiron ventilators were fitted over the doors and windows. Each lavatory contained a wash basin and water closet, also a mirror and towel hooks. The pan served also as a urinal, as on raising the cover the seat also rose, unless held down. The pipe from the pan did not open directly to the air. On pulling up the handle the discharge valve was opened, and on pushing it down again a stream of water was forced into the pan to flush it. The windows of the lavatories were of brown ground glass, with a white pattern; the color could not be scratched. The accommodations of this car made the long journey of some 525 miles much more endurable than it would have been in an ordinary closed compartment, and the car was superior in every way to the first class saloon car of the London & Northwestern Ry. used between Liverpool and London (ENGINEERING NEWS, June 21, 1890).

As another example, the 2 P. M. express from Manchester to London, one of the fastest trains in England, consisted of five new cars, used specially for this train, each carried on 6 wheels, and both of the end cars having a guard's compartment at the end, with projecting sides and roof to allow the guards to see along the train. The third class compartments were fair examples of modern practice. They were wide and lofty, with spring cushions and padded backs to the seats, and large windows with spring blinds. The floor was bare; roof and upper part of partitions painted white; the lower part grained like oak, with door and window frames of polished wood. During a heavy rain storm water leaked in through the roof, and also splashed into the lamp globe. Oil lamps were used and gave a miserably poor and flickering light. From Manchester the train runs over the Manchester, Sheffield & Lincolnshire Ry. to Retford, where that line connects with the Great Northern Ry. by a long and sharp curve. From Manchester to Grantham the train was hauled by an engine of the M. S. & L. Ry.; it was an inside cylinder engine, with 4 coupled driving wheels, a four-wheel leading truck, tapering pipe smokestack, and an air or steam jet to throw sand under the driving wheels.

On the double track line between Finsbury Park and Highgate (in the suburbs of London) there are some pairs of single-track tunnels, each track having a separate tunnel. Ribbed or bastard skew brick arches for over-crossings of highways are also used, some of them making a skew of a considerable angle.

The unpunctuality of long-distance trains in England is rather surprising to a stranger, although in this respect the Great Northern Ry. is better than many other roads. The Aberdeen and London express, above referred to, was 12 minutes late at Edinburgh, 30 minutes at York and 36 minutes at Grantham. Beyond Grantham there was some very fast running, from 50 to 65 miles per hour, but the train was 40 minutes late at the King's Cross terminus, London. For the first half of 1890 the average fares per passenger were 87½ cts. for the first class 23½ cts. for the second class, and 16 cts. for the third class, the average rates per mile being about 2, 3 and 4½ cts.

[*To be continued.*]

E. E. R. T.

Upright Precipitating Tanks.*

One of the leading systems using these tanks is the Müller-Nahnsen, operated in Halle. The plant in this town is planned to treat a daily sewage of 800,000 galls. although, at present the quantity is less than a third of this amount. The plant consists of 2 tanks, Fig. 136, shaped like wells, and provided with a bypass to be used during repairs or exceptionally heavy storms. The sewage passes through a sand pit and mixing channel into the tanks by an opening embracing a third of the circumference. It then rises and finally escapes through a number of separate channels into the outfall. During the rise of 9¾ ft., the sludge is precipitated and collected in the bottom, whence it is removed by suction pipes. The same process is then gone through with in the second tank and the finer parts of the precipitate collected, although a single larger tank would probably suffice for the whole operation. In another Müller-Nahnsen plant in Ottensen the bottom of the tanks are conical, as shown

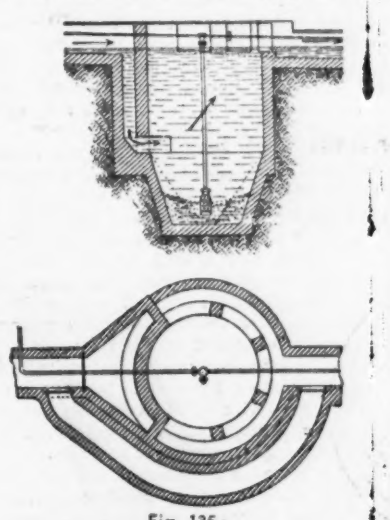


Fig. 136.

by the dotted lines in Fig. 136, in order to better collect the sludge about the suction pipe. In this plant the inlet and outlet are simply two openings diametrically opposite, although not on the same level. This arrangement did not give a good circulation, and in a recent plant in Halle the effluent escapes from around the whole upper rim.

The Röckner-Rothe system was tested experimentally in Essen, and finally permanently adopted. The apparatus, Fig. 137, consists of a conical well, in which the bottom of an iron chamber, or bell, is held by means of suitable beams. The sewage flows into the well through an iron pipe after being mixed with the charge of chemicals. A skeleton frame of iron rods, arranged like an umbrella, causes the sewage to become thoroughly mixed with chemicals before it rises to the top of the bell, whence it flows into an iron outfall pipe leading to an open drain. The motion of the sewage in the bell and outfall pipe is entirely automatic, being due to the slight difference in elevation between the water level in the inlet and outlet drains caused by the friction of the apparatus. In order to start the siphon, a small tube

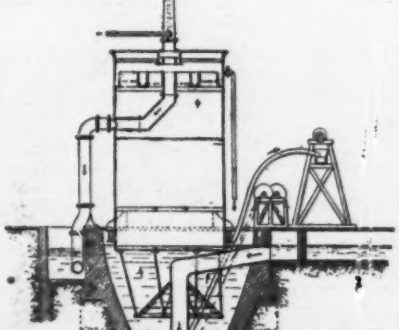


Fig. 137.

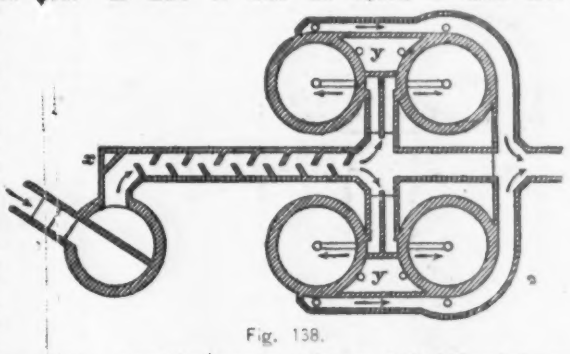


Fig. 138.

is attached to a pipe at the top of the bell and the air above the water removed by a small air pump. This pump is also operated a short time each day, in order to remove the gas that collects. The particles of sludge are precipitated on the iron frame and at the bottom of the well, where they enter a suction pipe and are thus removed. A small pipe leads from the upper level of water in the bell to a waste channel, and is used to remove the globules of fatty matter, which collect on the surface.

The plan of the Essen plant is shown in Fig. 138, from which it will be seen that the sewage passes through a grating, sand pit and salmon-way before entering the precipitating tanks, of which there are four. The spaces marked *y* receive the effluent of the grease drains and the chemicals are added at *x*. With a maximum daily sewage of 636,000 cu. ft., and all the tanks in operation, the sewage will pass upward through the bells at a velocity of about 0.16 ins. a second, and will remain in the tanks about 40 minutes. The average daily flow is only about 459,000 cu. ft., while the sewage takes 55 minutes to pass through the tanks and has a velocity of only 0.12 ins. a second. Experiments show that a velocity of 0.23 ins is allowable. On clear days, when the sewage may sink to 433,000 cu. ft., one of the tanks can be cut off and repaired if necessary.

A similar plant is in use in Brunswick, where 2 tanks like those shown in Fig. 137, are employed to treat 17,650 cu. ft. of sewage containing excrement a day. The appliances are of sufficient size to treat 158,900 cu. ft., which will be eventually supplied by the sewerage system being built. Cologne is also experimenting with the apparatus. The good results so far attained by the apparatus are to be ascribed to the very slow velocity of the current in the tanks and bells.

A siphon may be started by pouring in water, as well as by drawing out air, at its highest point. Advantage has been taken of this fact by SAGASSER in designing the tank shown in Fig. 139. This consists of 2 concentric cylinders and 2 pipes. The apparatus is filled with water by closing the cocks, *y*, *v* and *z* and opening *x*. After-

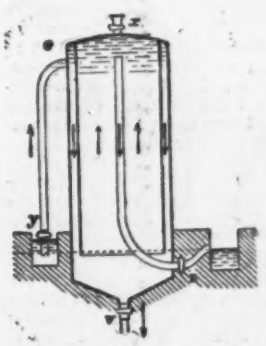


Fig. 139.

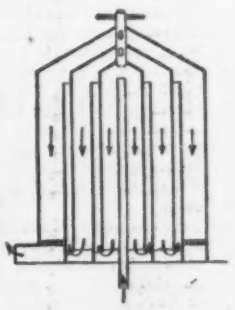


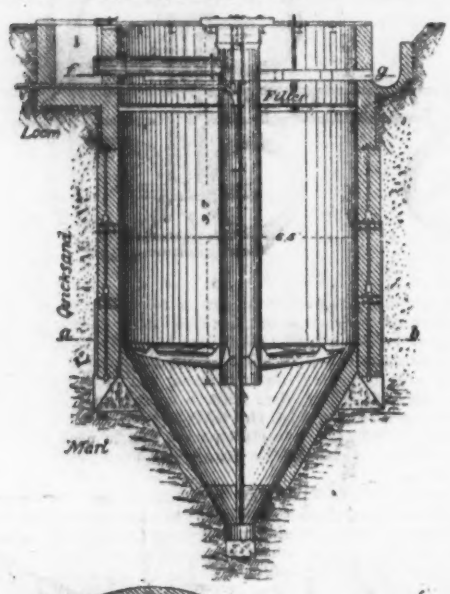
Fig. 140.

ward, when *y* and *z* are again opened, a constant stream flows from the inlet channel at *y*, to the outfall drain at *z*. In order to remove the sludge or clean the tanks, *y* and *z* are closed and *x* and *v* opened. Although the apparatus is quite compact, it is possible that with large dimensions the circulation would not be perefectly satisfactory. In this respect, an improved form, invented by PICHLER and SEDLACECK, Fig. 140, would probably be more satisfactory, since there are a large number of ascending and descending currents, caused by a series of concentric cylinders closed below by conical bottoms as shown. The sewage enters and

*Abstract from BAUMEISTER'S work on "Street Cleaning and Sewerage," to be published shortly by ENGINEERING NEWS PUBLISHING CO.

eaves the tank at the top while the sludge escapes through a pipe at the bottom.

The last two devices are possibly not suited for the large quantities of sewage which are furnished by cities, but their construction is interesting as containing many points of similarity with one of the latest German precipitation plants, that at Dortmund. This is calculated for a daily maximum of 793,000 cu. ft. during storms, 264,000 cu. ft. during dry weather, and a maximum discharge of 4.6 cu. ft. per second. The average annual flow per second may be assumed to be about 7 cu ft. Four tanks similar to those shown in Fig. 141 are employed; they are shaped like wells with a



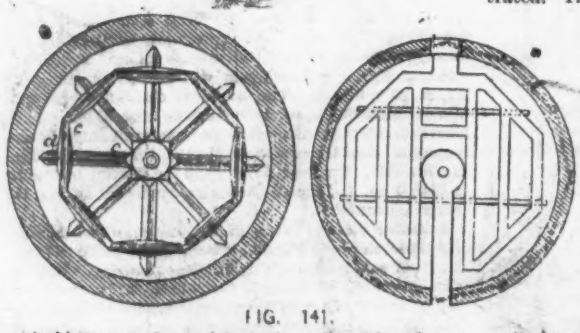


FIG. 141.

conical bottom and are driven through quicksand to a firm stratum of marl. The circulation is kept up by hydrostatic pressure alone. The suction sludge-pipe passes through an axis of the well, as shown, and is surmounted by the inlet-pipe, reaching down to the base of the conical portion. The sewage flows from the bottom of this inlet pipe through a set of radiating channels, open at the bottom, which insure a good circulation in the tank. Experiments are still being made to determine the most suitable form of these arms. A filter is placed just below the outlet drains and in this way the light floating particles are retained. The calculated maximum velocity in the tank is 0.08 ins. per second while the average is fixed at about 0.06 ins. As compared with the Müller-Nahnsen system, it is more compact and there will probably be a more uniform circulation; compared with the Röckner-Rothe system it is less expensive and more simple, although the removal of the sludge offers greater difficulties. The intention is to remove this sludge by means of tight vessels from which the air has been exhausted. On connecting the sludge pipe with one of these, it is hoped that the sludge will be forced into the vessel by atmospheric pressure.

A combination of this system with some of the features of the Röckner-Rothe plan has been proposed but not yet tested. In general, it is safe to say that with our present knowledge, the nature of the ground on which the plant is to be built will largely determine the system that is adopted.

The Busk Tunnel.

In the letter of Chief Engineer B. H. BRYANT on this tunnel, in our issue of Jan. 17, the "100 HP. engine" for use with the dynamo, etc., should read 10 HP. And in the foot note to that letter we find that an error is copied, which was made originally by the *Rocky Mountain News*. The curvature saved by the new tunnel is 2,000°, an economy much better worth talking about than the "2 x" first given.

Hydraulic Charging Crane.

(WITH INSET.)

We are indebted to Mr. C. M. CLARKE, of Pittsburg, Pa., for the following description of a hydraulic charging crane made under patents granted to Messrs. GEORGE F. MCCLEANE and WM. M. FABER, JR. Mr. CLARKE designed the details as here shown, and furnished all the shop drawings.

The illustrations given show side and end elevations, partly in section and partly in plan, and also small detail of the tongs in operation. The mast of the crane is built up of two heavy 12-in. channels bolted to the lifting cylinder *B*, at the bottom, and to a block secured in a rigid center bearing at the top.

The entire weight of the crane rests on a nest of conical cast steel rollers, revolving on a faced bevel plate and secured by internal and external straps. This plate is socketed in position on a bed plate resting on a brick foundation. The jib of the crane is secured to a casting resting on top of the ram. This jib is made of two 10-in. channels, and is stayed by two guy rods, provided with anti-friction wheels and secured to an extension of the main mast.

The carriage at the charging end of the jib is mounted on anti-friction rollers and is operated by the cylinder *C*. The "peel" is supported by plates depending vertically from the carriage, as shown. This peel is made from a forging, and has a reasonably extended keel provided with rollers. Mounted on the peel is the cylinder *D* for manipulating the tongs. This cylinder is connected to a 4-way valve by an elbow-joint connection.

As shown in the smaller sketch, the tongs are made of steel castings and have an open and closing action operated by the cylinder. These tongs embody the really novel features of the crane illustrated. They are brought immediately over a loose pile, and a little back of its center, lowered and tightened. Upon raising the mast the pile will assume the slanting position shown in the drawing, and is so charged into the furnace without any displacement. In withdrawing the charge the action is the same, and a revolution of the crane by the ground cylinder *A* brings the charge in the proper position over the table.

The three 4-way and one 3-way valves used are of the Cutchlow type, and all the valves are operated by the one man stationed on the crane. The connections between all moving parts and the ground-cylinder are made with hydraulic hose. Three of these cranes are now in constant use in the plate-mill of Messrs Moorhead, McCleane Co., of Pittsburg, Pa., and they give perfect satisfaction. We have no doubt that these gentlemen will answer any inquiries that may arise concerning further details of this device.

Machine for Making Briquettes for Cement Tests.

An extended series of cement tests has been carried on during the past year in the engineering laboratory of the State University of Iowa, under the direction of Prof. CHAS. D. JAMESON. The great number of briquettes tested (over 32,000) made their manufacture by hand a very tedious process, to say nothing of the well-known difficulties in securing uniform treatment of the briquettes in making them by hand. As is well known, this is one of the chief obstacles in comparing cement tests made by different engineers.

The greatest speed attained in making briquettes by hand was 10½ per hour; and as this rate of progress would have made impracticable the carrying out of the cement tests on the extended scale originally planned, the machine illustrated was designed by Professor JAMESON and has been used for making nearly 30,000 briquettes.

Fig. 1 is an elevation of the machine and Fig. 2 is a plan view. The principle of the machine is very simple. A vertical cylinder, whose cross-section conforms to the outline of the standard briquette, receives a charge of the mixed cement from a hopper at the side, through a passage shown in Fig. 3. In this cylinder a closely-fitting piston is worked by a hand lever, so that the charge of cement in the cylinder may be subjected to a pressure of about 175 lbs. per sq. in. The bottom of the cylinder is raised above the bed plate a distance equal to the thickness of a briquette (1 in.), and in this space works a triangular block, shown in Fig. 4, having two holes of the same cross-section as the briquette.

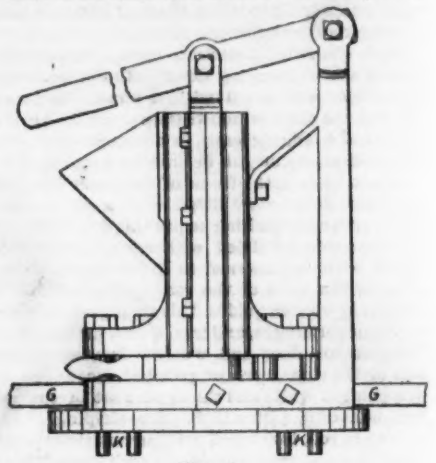


Fig. 1.

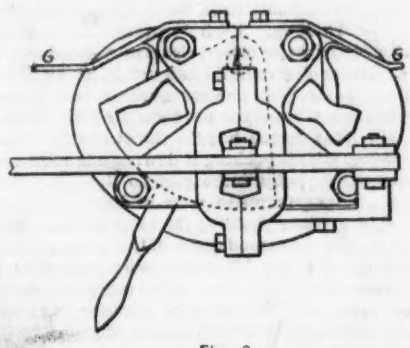


Fig. 2.

This block can be oscillated to bring either of these holes beneath the cylinder. When one hole is in this position, however, the other is clear of the cylinder at one side, and the briquette of cement which has been pressed into it can be lifted by a plunger, worked by the lever *G* and guided by the pins *K K*. Owing to the pressure used, the briquettes are hard enough to handle as soon as lifted from the mold, and they are at once removed and placed on a glass slab.

Fig. 3.

Fig. 4.

In practical working it has been found possible to make briquettes as rapidly as 600 per hour. The machine may be conveniently worked by two men, one feeding the cement to the cylinder and operating the long lever, the other swinging the molding plate, Fig. 4, working the plungers, and taking away the briquettes. The machine is not presented as by any means perfect, for it was built at the smallest possible cost, and with no knowledge as to whether a satisfactory machine could be built on the principle. It has done its work, however, very well, and has made possible a much more extended series of tests than could otherwise have been made.

In making briquettes with this machine the sand and cement are first thoroughly mixed. The material

is then weighed out in quantities of 10 to 20 lbs., and mixed in a zinc trough with the minimum amount of water required. It is not advisable to mix larger quantities at a time on account of the liability that the cement may begin to set before it can be made up into briquettes.

In our issue of Jan. 3 a very different form of briquette-making machine, in use by the engineers of the St. Louis Water-Works extension, was described. The "jig" for mixing, which was there illustrated, might perhaps be used in connection with Mr. JAMESON's machine for making the briquettes with satisfactory results.

The Right to Damages for Stoppage of Contractors' Work.

The right of contractors to recover damages in case of the abandonment of work on which they have entered has been affirmed by a decision of the Alabama Supreme Court in the case of Danforth & Armstrong vs. the Tennessee & Coosa R. R. Co. The plaintiffs took a contract in May, 1888, to build the Tennessee & Coosa R. R. in Alabama. After beginning the work and sub-letting portions of it to various contractors, the railway company failed to raise the necessary funds and was placed in a receiver's hands, and the contractors were forced to abandon the work. Suit for damages was brought in the Circuit Court and was decided against the contractors, who appealed to the Supreme Court. Here the decision was reversed. The following, which is of much importance to engineers and contractors, is extracted from Justice COLEMAN'S decision.

Where one party in compliance with his contract enters upon its performance and is wrongfully forced to abandon it, before its completion, without fault on his part, he is entitled to recover damages for its breach. If profits formed a constituent element of the contract, their loss, the natural and proximate result of the breach, and such as was reasonably in contemplation of the contracting parties, and the amount can be estimated with a reasonable certainty, such certainty as satisfies the mind of a prudent and impartial person, they are recoverable as damages. On the other hand, if profits are merely speculative, conjectural, or too remote, they are not allowable.

Where the proof fails to show that a profit would have been realized, the recoverable damage consists in the reasonable expenditures made and loss of time, less the value of the material on hand. If the proofs show that profits would have been realized had the party not been prevented from performing the contract, they are recoverable; and the measure of profit as damages is the difference between the cost of doing the work and the price agreed to be paid.

In estimating the cost of doing the work, the less time engaged, and release from the care, trouble, risk and responsibility attending a full execution of the contract should be included in the estimate.

The contract sued upon in the present case specifies with great particularity the price to be paid for excavation of earth, loose and solid stone, timber and material for bridges, trestle work and culverts, and for all materials to be furnished and work to be done. There is comparatively but little difficulty under such a contract in determining the price to be paid and the cost of doing the work; and the difference between the two, which constitutes the profits, is recoverable as damages. The testimony of DANFORTH and O'HEARN intending to show the difference is erroneously excluded by the lower court.

When a party has in part performed his contract and is wrongfully discharged, or forced to abandon the work, he may sue upon the contract and recover the price agreed to be paid for the work already performed, and may in the same suit declare for damages sustained by the breach of the other party in forcing him to abandon the work before its completion.

By the terms of the contract the plaintiffs were to be paid monthly, less 10%, reserved until the completion of the contract, payable on the 10th day of each month, for the work performed the preceding month. Upon being wrongfully forced to abandon the work without fault on their part, the plaintiffs were entitled to recover for the work done, including the 10% reserved, at the contract price, and could declare in different counts for damages sustained by reason of the breach of contract, and recover as profits whatever the proofs would show they would have realized from the unfinished work.

The contract provides that no work shall be sub-contracted without the written consent of the engineer in chief. This provision was intended for the benefit of the defendant. It was entirely competent to show that the defendant waived this right or benefit, and for this purpose it was proper to prove by the chief engineer that he knew sub-contractors of the plaintiffs were at work; that he, as chief engineer, directed them when and where to work, and that he estimated the work of the sub-contractors and gave the estimate to plaintiffs, knowing that it had been done by sub-contractors for plaintiffs; and it was competent to show that the president of the company was appraised of all these sub-contracts and permitted the work to be done without objection.

The measure of damages for failure to pay money on the day it is due is the interest which accrues thereafter.

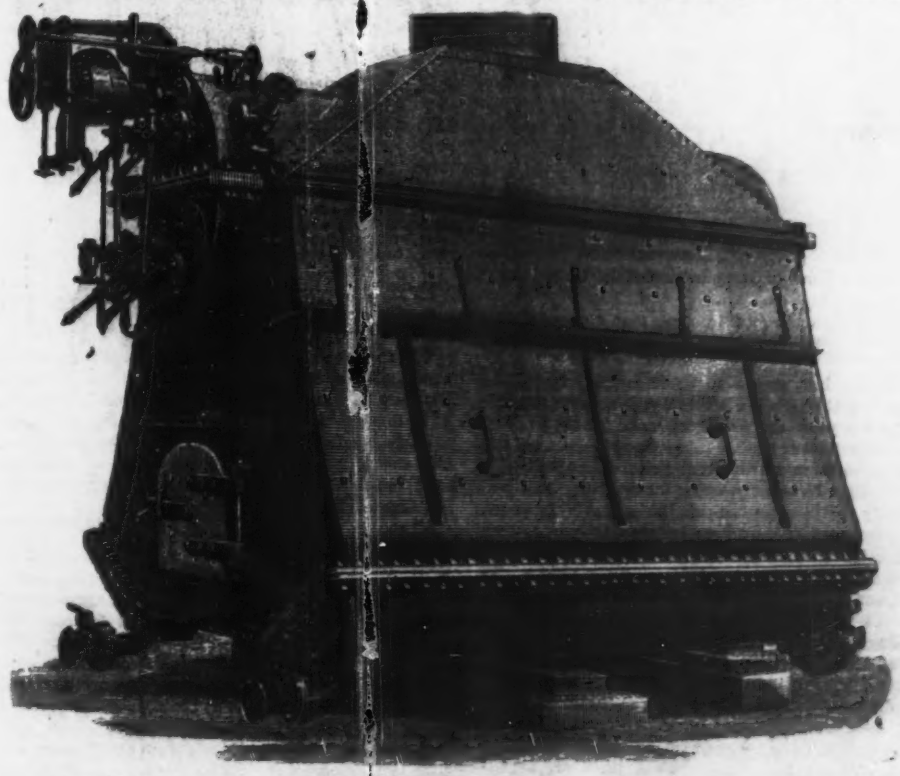
The Yarrow Tubulous Boiler.

Our English engineering contemporaries show in their issues of Jan. 16 a new tubulous boiler built by the firm of Yarrow & Co., Poplar. It is a water-tube boiler suitable for marine purposes, and their solution of the troublesome problem involved is deemed complete and satisfactory by the English press.

The ruling principles of the new boiler are that a straight tube, open at both ends, unencumbered with circulating devices and set on a steep incline, is the cheapest tube in which water can be boiled, and in which water will circulate most easily. Both ends of the tube are accessible; the tubes are free to expand and contract; the tubes are in groups and both ends are under water.

In the Yarrow boiler these tubes are of steel, about 1 in. in diameter and 4 ft. long, and perfectly straight. The upper receiver and the lower water pockets are castings of steel or tough cast iron. The flanges on these are planed and bolted together like the parts of a steam cylinder and are made steam and water tight. The tubes are fixed in in the ordinary way. The whole boiler is covered with a plate iron casing, lined with fire tile and provided with doors, as shown, that permit the tubes to be swept. There are 8 rows of tubes, staggered in the plates at each side of the fire.

In operation the products of combustion pass from the grate through the tubes over the central drum

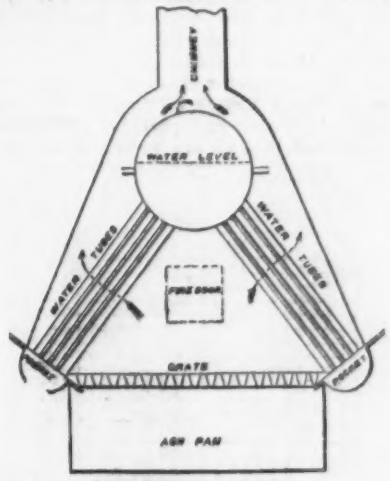


THE YARROW TUBULOUS BOILER.

to the chimney above. In circulating, the water descends in the outer rows and rises in the inner rows, as is proven in a model with glass tubes. The steam is produced in the outer tubes, but the bubbles are carried down instead of up, as in the inner tubes.

The result is that the boiler cannot prime and must give dry steam; the action of the fire is practically the same on all the tubes from one end to the other of the grate. Two years' experiments show that it works admirably with forced draught and under pressures ranging from 170 to 200 lbs. Mr. YARROW galvanizes the entire boiler after the tubes have been fixed, inside and out, by putting each section into a zinc bath. This zinc, on the outside, will doubtless soon yield to the sulphur in the coal, but the interior will remain practically intact, and the galvanizing is believed to be an important innovation on present practice.

The boiler illustrated, says *The Engineer*, will indicate 250 HP., though the one boiler could readily be enlarged to 500 HP. The deck space occupied by four such boilers would be about the same as for two Scotch boilers giving 2,000 I. HP.; but the cubic



Cross-Sectional Diagram.

space would be less, as the boiler would stand lower. The feed water, it should be mentioned, is delivered into the central drum and steam can be gotten up in about 20 minutes, or one-third the time required by a locomotive boiler. The tubes are so small that the failure of one or two would not endanger life in the stokehole.

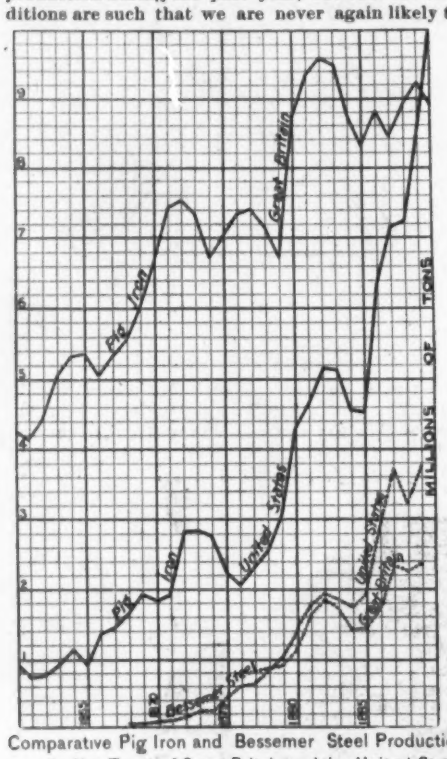
The Kupferle Hydrant.

Our attention has been called to the criticism on this hydrant made in describing it in our issue of January 24, 1887. We remarked then that there was some danger that under high pressure water might leak past the upper leather cup and freeze in the casing, causing damage. We also suggested that a small hole bored at the base of the casing would obviate this difficulty. We want to say now, in

justice to the inventor, that there *is* such a hole in the casing as made, and put there for the very purpose suggested. Thanks to a blurred proof before the writer of the criticism the hole was not noticed, but it is very plain in the cut as printed in our regular issue.

British and American Iron and Steel Production.

The accompanying diagram, reproduced from the current issue of the *Iron Age*, shows graphically the facts as to iron and steel production, on which we commented last week, and in particular lends force to the prediction which we hazarded—that not only did we pass Great Britain handsomely in pig-iron production during the past year, but that the conditions are such that we are never again likely to



Comparative Pig Iron and Bessemer Steel Production (in Net Tons) of Great Britain and the United States 1860–1890.

(N. B. The pig iron production of the United States for 1890 extends considerably above the top limit of the diagram, up to a total of 10,307,028 net tons.)

fall below her, unless in some single exceptional year; but that, on the contrary, it is quite possible that a few years more will see us so far ahead of all other countries that we shall occupy the position in relation to them which Great Britain occupied prior to 1870-80. Evidently some far-reaching and presumably permanent causes have been at work to cause such tremendous increase in our pig-iron production since 1882, while Great Britain has been standing still. It can hardly be tariff, because the tariff has been a substantially constant force since 1861. It would seem to us as if it was the rapid opening up of our mineral resources by great improvements in transportation, while the development of the corresponding British fields had approached closely to its permanent economic limit in 1882. Not that there may not continue to be an increase in British iron product hereafter—there no doubt will be; but the physical limit of advantageous and economical expansion has been about reached.

Tie Consumption on French Railways.

M. Henry Mathieu, in the *Revue Generale des Chemins de Fer*, No. 4, 1890, treats of the consumption of wooden ties on the six principal and the State railways of France for the year 1889. The lines referred to are the West, North, East, Orleans, Paris-Lyons-Mediterranean, Middle and State railways. There companies used in 1889, 3,213,475 ties in all; 2,372,079 being for maintenance and 841,396 for new construction and double track. From 75,000 to 80,000 metallic ties of various types are now in use on the roads above named. The combined length of these railways, as operated on Jan. 1, 1889, was 19,503 miles. On 2,754 miles of track of secondary systems of railway, 153,300 ties were used for maintenance and 195,700 in construction, for the same year. The total of ties consumed in 1889 was therefore 3,562,475.

M. Mathieu shows that in 1883 out of a total of 4,572,789 ties consumed, 1,097,370 came from outside of France. This import of ties has steadily decreased, until in 1888 it was only 166,811, and in 1889 all the ties used came from France. The ties consumed on secondary and local roads do not enter, however, into this calculation, as the quantity is unknown to the writer. The wood used in these ties was as follows: 2,155,921 ties of oak; 696,602 beech ties, and 388,833 pitch pine ties.

Money Value of Good Roads.

Under date of Jan. 20, 1891, Messrs. Thos. P. Roberts, Charles Davis, Alex. Dempster and Thos. H. Johnson, a committee of the Engineers' Society of Western Pennsylvania, submit a final report on the improvement of country roads. With this report they also submit a draft of an act "for the location, opening, vacation, construction and maintenance of highways, roads and bridges" in Pennsylvania.

The first part of the report relates to the urgent necessity for better roads for developing the State internal traffic, and the arguments advanced are practically the same as those of the previous report of this committee, made in March, 1889. Some portions of this, however, are well worth repeating, especially the parts relating to the difference in cost of hauling produce, etc., over good and bad roads. From the old experiments of Morin, still recognized as an authority, the committee prepared the following telling exhibit, one that any man can read:

Average Loads for One Horse on Different Roads and Grades.

Kind of Road.	Grade. 10%	5%	Level.
	Lbs.	Lbs.	Lbs.
Street pavement, dry and clean	1,090	1,920	8,300
" " muddy	1,040	1,800	6,250
Macadamized Roads—			
Best, dry clean and smooth	1,000	1,840	6,700
Good, moist or with little mud	1,000	1,630	4,700
Bad, ruts and muddy	890	1,390	3,000
Very bad, deep ruts and stiff mud	740	1,040	1,840
Clay Roads—			
Best condition	930	1,500	3,600
Average "	660	900	1,400
Newly worked, not muddy	600	780	1,100

The above table needs little comment; but at the the legal grade of 5°, or 8.85 per hundred, it means that the load of one horse is 1,150 lbs. for pavement, 1,000 lbs. for macadam, and 700 lbs. for clay road, assuming each to be in good average condition. For average condition of each class of road, the loads hauled are in the following proportions, taking that of clay roads as 1:

	Macadam.	Pavement
On level	2.75	4.46
On 5% grade	1.70	2.00
On 10% grade	1.43	1.58
On legal grade of 5°	1.56	1.64

In discussing the cost of handling the agricultural products of the State the committee figures that about 3,250,000 tons must be hauled an average distance of 5 miles to reach a market or steam conveyance to market. Two loads per day are assumed and $2.50 per day is taken as the cost of a two-horse team. The cost of moving this tonnage over clay and macadam roads would contrast as follows:

	Clay Road.	Macadam.
Load for two horses	1,400 lbs.	2,180 lbs.
No. of loads for 3,250,000 tons	4,643,000	2,981,000
Cost ($1.25 per load)	$5,703.750	$3,726,250
Difference, $1,977,500.		

The $2,000,000 thus annually wasted is enough to keep 30,000 miles of turnpike in repair at an annual expenditure of $66 per mile. Taken as days' work for a man and two horses, we have 2,321,000 on clay roads, and 1,490,000 on macadam; a loss of 831,000 days' labor, that could be devoted to other useful purposes.

Space forbids the reprinting of the act proposed for bringing about the desired improvement in roads but we are pleased to note that especial stress is laid upon the qualifications of the man who is to control the work in each county. He must be a man of sound judgment and extended practical experience with men; a civil engineer of undoubted ability, and then be left alone with full responsibility for his assistants, whom he appoints.

A summary of principal points embodied in the proposed act will serve as a key to its general tone and purpose. This is given as follows:

1. Roads to be divided into two classes—roads and high ways.
2. Highway tax to be levied on all property in the county.
3. State aid to be furnished each county for highways.
4. Thirty per cent. of State tax on corporations and 7½% of State tax collected in each county set apart for highways; and the portion of tax on corporations set apart for highways to be distributed among the several counties in proportion to the highway and road tax collected in the same.
5. Counties to construct and maintain all highways within their respective limits, under control of county officers.
6. Townships to construct and maintain all roads within their limits, under control of township road directors, with nominal compensation.
7. Road and highway tax to be paid in cash.
8. Provision for a more practicable and efficient system of road viewing.
9. A certain percentage of money contributed by the State, counties and townships for road purposes, to be expended in permanent improvements.
10. Cost of building highways and roads to be divided so that each interest benefited by the improvement shall bear its equitable share.
11. Providing a system of supervision which will not be too burdensome for the weaker counties, and which may be extended to meet the wants of the large and wealthy counties.
12. Providing for reports which will furnish reliable statistics of roads and highways of the commonwealth, and moneys expended thereon.
13. Providing for suitable protection for the public, where parties or corporations exercise the right of occupying, altering or changing the roads and the highways of the commonwealth.
14. Embodying in the law such general provisions as will be equally applicable to the different sections of the State, and leaving sufficient discretion with the officers charged with its execution to enable them to meet the peculiar wants of each district.

The caisson of the new Simpson dry dock at the League Island Navy Yard was tested in the outer gate sill on Feb. 5, in the presence of the commandant; Civil Engineer Peary, in charge of construction; and the contractors, Messrs. J. E. Simpson & Co. The dock will probably be opened early in March.

A bridge over the East River is the subject of a bill to be presented to the present legislature. The bridge would cross between the foot of Broadway, in Brooklyn, and Grand St., in New York. The capital mentioned, to start with, is $3,000,000, and the bill contains provisions for its purchase by the two cities, or by either of them.

A somewhat novel draft rigging is being applied to 200 hopper bottom coal cars of 60,000 lbs. capacity now building for a Western road. All draft timbers are done away with and the drawbar is run through the end sill, the draft rigging being attached directly to the center sill. This arrangement saves the expense of draft timbers and makes a car which will stand heavier blows in collisions, since the floor of the car may be considered as a column whose strength to sustain compressive strain is greatest when the force is applied at the plane through its center instead of several inches below the floor level, as is the case with the ordinary draft rigging. The only objection to this plan seems to be that the center sill is expensive to replace in case of its injury by breakage of the draft rigging. The above cars are to have M. C. B. couplers and air brakes.

The asphalt pavements of New York now exceed in area those of London or Paris, says Commissioner Gilroy in his report for 1890. The figures given for this city are 743,634 sq. yds., covering 34.21 miles of streets. Washington, D. C., however, is still ahead of New York, as on Sept. 15, 1889, the last report on hand, that city reported 37.9 miles of "sheet asphalt" streets, covering 830,259 sq. yds. Washington then had in addition to the above 38.2 miles of old coal tar pavement, now generally covered with a thin wearing surface of asphalt.

A sectional dry dock, 300 × 60 ft., is being built at Port Hadlock, about 5 miles from Port Townsend, Wash. It will be built of timber, at a cost of $250,000, and will accommodate the class of

vessels visiting Puget Sound. Capt. DONCASTER, of Tacoma, Wash., is superintending the construction.

THE MODEL OF THE CHICAGO AIR SHIP can fly, to some extent, as was demonstrated on Jan. 30. This 30-ft. long model was driven by electric power conveyed by a wire from batteries located on the floor of the building. The air ship rose slowly and moved around in a circle about 50 ft. in diameter, and in a second trial reascended with a spiral course. It moved slowly, had no self-contained motor, was without car or passengers, and was guided, to some extent at least, by a cord. Its success was greater than was expected by many present, but was far from realizing the promises made so freely.

A MODEL OF A LINE-OF-BATTLE SHIP is proposed as one of the interesting exhibits at the World's Fair in Chicago. This model would rest upon piles, but would present the appearance of being moored to a wharf. The ship will be complete in all the fittings belonging to an actual ship of this class, with guns, turrets, torpedo tubes, nets, booms, boats, etc. The dimensions would be the same as those of the ships of this class now being built by Messrs. Cramps. The length would be 343 ft. and the extreme width 69 ft. 3 ins. The 13-in. and 8-in. guns to be used would be models only, but otherwise fitted up as actual guns. The smaller guns would be furnished by the government

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Middletown & Cincinnati.—Tracklaying is now in progress on this railway, and it is expected to have the line completed from Middletown to King's Station, O., this season.

Lancaster & Hamden.—The present status of work on this road is as follows: Track laid from L. & H. Junction toward Laurelsville, 10 miles, and from Vinton Station to Vinton Furnace, 6 miles. Work is in progress on the entire line from Columbus, O., to Wellston, with a branch from Locust Grove to Vinton Furnace, and belt line at Wellston, a total of 86 miles, and is to be completed in 1891. Forty four miles are graded, and the cross ties are laid ready for the rails.

Philadelphia & Reading.—The Philadelphia & Easton R. R. which is projected to run from New Hope, Bucks County, to Easton, Pa., has passed under the control of this company, and Carroll R. Williams, of New York City, has been supplanted as president by Charles F. Kindred, of the Reading Co. Arrangements have been made for the construction of the road, and as soon as the New Hope extension of the Northeast Pennsylvania R. R. is in good working order work will be begun on the Philadelphia & Easton, starting at New Hope. This will probably be in a few weeks.

Northern Adirondack.—This company has filed a map showing the location of an extension of its railway from Tupper's Lake to Gouverneur, N. Y.

Western New York & Pennsylvania.—The right of way has been secured for the line from Swaine's to Ross's Crossing, near Nunda, Pa., 5 miles, and the contract let to A. C. Barrow, of Nunda. Work will begin at once.

Chicago & West Michigan.—It is reported that this company will build a line from New Buffalo, Mich., to Hammond, Ind. The object of the new branch is to obtain a line into Chicago independent of the Michigan Central R. R.

Delaware River.—It is reported that this road will be extended to Pennsville, Salem, Bridgeton and Millville, N. J.

Baltimore & Ohio.—This company has secured control of the Pittsburg & Western R. R., and will hereafter operate it as a portion of its system. It is stated that the Pittsburg & Western R. R. will be double-tracked at once.

Delaware, Susquehanna & Schuylkill.—J. B. White, of Drifton, Pa., Treasurer, writes as follows:

This railway is projected to run from Drifton, Pa., via Eckley, Stocton, Hazleton, Tomnicken and Derringer to Gowen, Pa., with branches to Beaver Meadow, and to Oneida and Nelson City, a total distance of 35.5 miles. The surveys are nearly completed, and the right of way has been secured. The work will be about average; maximum grade, 55 ft. per mile, and maximum curve 9°. There will be several bridges of about 70 ft. span each. The contract for constructing the greater part of the line has been let to Brown Brothers & Co., of Hazleton, Pa. The contract for the remaining section will be let in the spring. Construction is now in progress, and about 6 1-10 miles are completed. The company was chartered in April, 1890, and the road is to be completed during the present year. Edgar Kudlich, Drifton, Pa., is the engineer in charge of work.

Sandusky, Columbus, Lake Erie & Southern.—John McKelvey, of Sandusky, O., President, writes as follows:

Two lines known as the East Line and West Line have been surveyed for this railway from Sandusky to Columbus, O., 105 miles and 108 miles long, respectively. The work will be very light; maximum grade 26.4 ft. per mile and very light curves. There will be bridges crossing Honey Creek, Sandusky River and Olentangy River, 50 ft., 90 ft. and 170 ft. long, respectively. The rock bed and bridges will be prepared for two tracks; oak cross-ties laid 2,640 to 3,000 per mile, and steel rails weighing 70 lbs. per yard will be used. The route is through a rich coal and iron region and the principal business of the road will be in coal, iron ore, lumber, stone, and the general freight and passenger traffic. Work is now in progress securing right of way and local aid. It is expected that about $300,000 will be secured in notes payable 30 days after date of completion of road to place where aid is given. The stockholders will advance the money necessary to build the first 15 miles, after which the money will be secured by sale of bonds. The contract has been let to the Sandusky Construction Co., which will begin work in the spring. The road is to be completed July 1, 1892. The company was chartered April 20, 1889. The officers are: President, John McKelvey; Secretary, Ed. H. Zurhorst; Treasurer, Truman B. Taylor, and Chief Engineer, Chas. O. Judson, all of Sandusky, O.

New York & New Jersey Terminal.—This railway company has been chartered in New York. A full description will be found in our "Engineering News" columns.

Aroostook & Penobscot.—This company has petitioned the Maine State Legislature for incorporation, with power to build a railway from Mattawamkeag, Me., via Sherman, Patten, Houlton, Presque Isle and Caribou, to Van Buren, 150 miles, with branches to Fort Fairfield, 12 miles; to Fort Kent, 75 miles and to the Bangor & Piscataquis R. R., 35 miles. This is probably the old Northern Maine R. R. Co. reorganized.

Erie & Central New York.—At a recent meeting of the stockholders it was voted to issue bonds at once and to use the proceeds to build and equip the line. The road runs from Cortland to Cincinnatus, N. Y., 18 miles, and is partly graded. It is stated that parties in New York will advance the money for completion as soon as certain pending litigation is done away with.

New York & Suburban.—Chartered in New York to build a railway from Bronxdale, Westchester Co., to Jamaica, Queens Co. The road will commence at a point near Bronx Park, and cross the East River at Ferry Point to College Point, and thence run to Flushing, Jamaica and Woodhaven. Among the incorporators are: David M. Talmadge, Wm. Caldwell and others of New York City.

SOUTHERN.—Existing Roads.

Albany, Florida & Northern.—This road is practically completed between Albany and Cordile, Ga., 35 miles. Part of the rolling stock has arrived and regular trains will be run at once. About 20 miles of the line were completed last year.

Chattanooga Southern.—This road will be open for traffic from Chattanooga to Gadsden about April 15. The entire roadbed has been graded, and tracklaying continues on the southern end. Two gangs, one from Gadsden and the other from Pigeon Mountain tunnel, are working toward each other. The line from Chattanooga to the tunnel is in operation, two trains running each way daily. The tunnel is nearly finished, only about one-fourth of the entire distance remaining to be completed.

Atlantic Coast Line.—The contract has been let for grading the line from Fayetteville to Rowland, N. C., 42.5 miles.

Louisville Southern.—Work on the extension of the Richmond, Nicholasville, Irvine & Beattyville R. R., which was abandoned some time ago, will be resumed soon. The road is now completed to 3 miles beyond Richmond, Ky., and considerable grading has been done on the remaining section to Irvine, Ky. It is also intended to begin work on the section from Irvine to Beattyville during the season.

Nashville, Chattanooga & St. Louis.—Engineers are now making the surveys for the Nashville & Cumberland Gap R. R., which is to connect this railway with the lines centering at Cumberland Gap. The contract for 18 miles is reported let.

Roanoke & Southern.—The forces of laborers now at work between Roanoke, Va., and the North Carolina line are being increased. Sufficient money has been secured to build the line, and work will be rapidly pushed.

Middle Georgia & Atlantic.—The Seaboard Construction Co. has been organized to build this railway from Atlanta to Savannah, Ga. The line is now completed from Eatonton to Newbern, Ga., 33 miles.

Cape Fear & Cincinnati.—This company has secured the charter of the Asheville, Atlanta & Knoxville R. R. Co., organized to build a railway from the mouth of Cape Fear River to Chattanooga, Tenn. It is stated that the contract for grading the section from Gaffney City to Catawba Falls, S. C., has been let, and that work is now in progress near Kennedy Shoals. C. H. Ragsdale, Lancaster, S. C., Chief Engineer.

Atlantic & Danville.—The contract for building the Danville & East Tennessee R. R., from Danville, Va., to Bristol, Tenn., 180 miles, has been let to the Interstate Construction Co. The latter has sublet 26 miles from Bristol east to James P. Edwards & Co., of New York City. Work will begin immediately at Bristol. J. W. M. Draper, Norfolk, Va., General Manager and Chief Engineer.

Projects and Surveys.

Georgia.—Bills incorporating the following railway companies have passed the Georgia State Legislature The Brunswick & St. Simon's Ry. Co.; North Georgia Ry. Co.; Vernon Park Ry. Co.; Southern National R. R. Co.; Alabama Eastern R. R. Co.; West Atlanta Street R.R.Co.; Millen & Southern R. R. Co.; Capitol R. R. Co.; Richland Gulf & Northern R. R. Co.; Cedartown Street R. R. Co.; Athens & Cornelia R. R. Co; Etna R. R. Co.; Atlanta, West End & Westview Street Ry. Co.; Jackson Ry. Co.; Macon & Indian Springs Ry. Co.; Suburban & West End Ry. Co., and the Atlanta & Northwestern R. R. Co.

Black Warrior.—A railway company by this name has been chartered in Alabama.

Alabama, Georgia & Florida.—W. S. Green, of Columbus, Ga., Chief Engineer, writes as follows:

This road is projected to run from Quincy, Fla., via Bainbridge, Colquit Arlington, Cuthburt and Florence, Ga., and Hutcheehubba, Tuskegee, Tallussee, Rockford, Shelby and Columbiana, to Bessemer, Ala., a distance of 380 miles. The surveys have been completed. About 200 miles will be light work and the remainder quite heavy; maximum grade 1¾° and maximum curve 6°. There will be bridges across the Flint, Chattahoochee, Tallapoosa, Hatchet, Coosa and Cahaba rivers, and a tunnel 1,000 ft. long through Shady Mountain, Ala. No effort has been made to secure right of way, but it can easily be obtained and no other local aid is desired. The principal business of the road will be in cotton, lumber, iron ore and general produce. The company was chartered in October, 1889, but no organization has been completed.

Thomasville, Silver Valley & Pee Dee.—P. C. Thomas, of Thomasville, N. C., writes as follows:

This road is projected to run from Winston-Salem, N. C., via Milledgeville and Ansonville, to Wadesboro, N. C. 99¾ miles. The preliminary surveys have been completed, and location will begin in the spring. The work will be about average. There will be bridges across the Pee Dee and Wharie rivers, 720 ft. and 200 ft. long, respectively, besides seven or eight smaller structures with spans of from 30 ft. to 70 ft. The principal business of the road will be in farm produce, ores, stone, coal and lumber. Negotiations for contracts are now being made. The officers are: President, John T. Cramer, and Chief Engineer, C. W. Pearson.

Albany, Boston & Florida.—J. W. Taylor, of Boston, Ga., writes as follows:

This road is projected to run from Albany, Ga., south through the counties of Dougherty, Colquit and Thomasville, Ga., and Jefferson, Taylor and Madison, Fla., about 130 miles. No surveys have been made. The route is through a fine timber country, affording easy work. There will be no large bridges. M. R. Mallette, of Boston, Ga., is President.

Dahlonega & Dawsonville.—Frank W. Hall, of Dahlonega, Ga., writes as follows:

The surveys have been completed for this railway, which is to run from Tate, Ga., on the Marietta & North Georgia R. R., via Dawsonville & Dahlonega, Ga., to Lula, Ga., on the Richmond & Danville R. R., a distance of about 65 miles. All of the right of way has been obtained and about $35,000 local aid secured. The road is being built in the interest of the marble quarries of Pickens Co., and its principal business will be in marble, coal, ore and farm products. The company was chartered in September, 1889. P. B. Lawrence is President.

St. Albans & Coal River.—W. C. Reynolds, of 232 Broad St., Charleston, W. Va., writes us that nothing in the way of construction is being done on this West Virginia railway. The road is projected to run from St. Albans, W. Va., to the Kentucky line. M. P. O'Herne, Charleston, W. Va., President.

Atlanta & Alabama.—L. E. O'Keefe, Atlanta, Ga., Secretary and Treasurer, writes as follows:

This road is to run from Atlanta, Ga., to Selma, Ala., 200 miles. The surveys have been completed, estimates made and right of way secured. The work will be light, with easy grades and curves. About 100 miles of the line is through a cultivated country and the remainder through a pine timber region. The principal business will be in cotton, timber, coal, iron and general merchandise. The company was chartered in 1887. H. B. Thompkins is President.

Bowling Green & Northern.—M. H. Crump, of Bowling Green, Ky., Secretary, writes as follows:

This road is to run from the Chesapeake, Ohio & Southwestern R. R. north to Bowling Green, Ky., about 50 miles. Between the Green and Barren rivers, 10 miles, the work is heavy, but the remainder of the line is very light work; maximum grade 79 ft. per mile and maximum curve 8°. There will be two steel bridges of 250 ft. span each and one tunnel 800 ft. long. The location is completed and estimates made for the line to Bowling Green, and preliminary surveys have been completed to Scottsboro, Ky., 25 miles further. The right of way has been secured and about $15,000 of the stock have been subscribed by Warren Co. Arrangements are being made to secure other capital, and it is expected to begin work in the spring. E. P. Reynolds & Co., of Rock Island, Ill., have the contract. The principal business of the road will be in timber, coal, iron ore and general produce. J. Proctor Knott, of Lebanon, Ky., is President.

Mobile, Jackson & Kansas City.—J. W. Nicol, of Mobile, Ala., Chief Engineer, writes as follows:

This road will be 182 miles long, and will run from Mobile, Ala., to Jackson, Miss. The location has been completed and about ¼ of the right of way secured. The work is light; maximum grade 1° and maximum curve 4°. There will be two drawbridges on the line. Negotiations are now in progress to secure the necessary funds for construction, and it is expected to let contracts within two or three months. H. Austill, of Mobile, Ala., is President.

NORTHWEST.—Existing Roads.

Illinois Central.—In an interview, Division Superintendent E. G. Russell is quoted as saying:

I had a consultation with President Fish relative to extending the road from Madison to Portage, Wis., a distance of about 40 miles, and from that point to Minneapolis and St. Paul. President Fish thinks that the Illinois Central should run into those cities. The decision to build is practically final. The question to be determined is the route to be taken. President Fish thinks that it is possible to build through a good section of country some distance from competitive roads and not by the Portage route,

Duluth & Winnipeg.—Grading on the line from Cloquet to Duluth, Minn., 14 miles, has commenced, and is to be completed by May 1.

Projects and Surveys.

De Kalb, Aurora & Eastern.—Chartered in Illinois to build a railway from Rock Island southwest to a point on the Illinois River, opposite Havana, Ill. Among the incorporators are: H. D. Wyman, J. L. Ellwood, and J. H. Lewis, all of De Kalb, Ill.

SOUTHWEST.—Existing Roads.

Kansas City, Watkins & Gulf.—The contract for constructing a 30-mile section from Alexandria, La., southwest to Spring Creek has been let to S. N. Bracey and J. A. Ware, of St. Louis, Mo.

Corpus Christi & South American.—About 25 miles of this Texas road are now graded and work is making good progress. The road is intended to run from Corpus Christi to Brownsville, Tex., 150 miles. It is stated that a stock company has been formed in Boston to furnish the necessary funds for building and equipping the line.

Fort Worth & Rio Grande.—This company is building 1½ miles of track into Fort Worth, Tex. It now uses the tracks of the Texas & Pacific Ry. into that city.

Projects and Surveys.

Gainsville, Henrietta & Western.—It is stated that the people of Clay and Archer counties have agreed to grade the roadbed and build the trestles for the proposed line of this road from Henrietta to Archer, Tex., 40 miles. It is probable that the Missouri, Kansas & Texas Ry. will operate the line when completed.

Springfield, Sedalia, Marshall & Northern.—A. M. Nelson, of Springfield, Mo., Chief Engineer, writes as follows:

This road is to run from Springfield, Mo., north through Buffalo, Duroc, Sedalia, Marshall, Miami, Lima, Cavendish and Chillicothe, a distance of 205 miles. Surveys are now in progress, eight miles being already located. The work will be about average, with easy grades and curves. There will be bridges across the Osage, Black and Missouri rivers. The principal business will be in coal, lumber and agricultural products. L. L. Bush, of Philadelphia, Pa., is President.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—The contract for building an additional 55-mile section of the Pacific extension from Bonner's Ferry to Kootenai Falls has been let to Burns & Chapman, of Spokane Falls, Wash. The contract will involve an expenditure of $1,000,000. The route of the line across Washington is not definitely known yet.——Grading on the Seattle & Montana R. R. is completed north of Marysville, and tracklaying will begin as soon as the rails arrive.——The Fairhaven & Southern and New Westminster & Southern lines will be opened for traffic about Feb. 15.

Northern Pacific.—Tracklaying on the Green River & Northern R. R. has been completed 7½ miles north of Durham, and will be rapidly pushed to Niblock's, Wash., 10 miles further.

Canadian Pacific.—It is stated that surveys are in progress for a branch from Mission Station, B. C., to Blaine, Wash., where connection will be made with the Great Northern line to New Westminster, B. C.

Projects and Surveys.

Tintic.—This company has been chartered in Utah to build a railway along the south shore of Utah Lake from Provo to Tintic, 50 miles, with the privilege of building further extensions into the Tintic mining regions when occasion demands. Geo. A. Rice, A. E. Hyde and others of Salt Lake City, Utah, are among the incorporators.

FOREIGN.

British Guiana.—Proposals for the construction of railways will be received until June 30 by the Secretary of the Government, Georgetown.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are proposed in the following places: Owensboro, Ky., address C. H. Todd: Lexington, Ky., address the Belt Electric Line Co.; Trinidad, Colo., address the Chamber of Commerce; Burlington, N. C.; Columbia, S. C., address J. S. Verner; Troy, N. Y., address the Troy & Lansingburgh R. R.; Derby, N. H.; San Marcos, Tex.

Quincy, Mass.—The Quincy Street Ry. has applied for permission to increase its capital stock from $50,000 to $100,000. The increase is wanted to pay $20,000 of floating debt, $5,000 for additional equipment, and $25,000 for an electric power plant.

Worcester, Mass.—A preliminary organization has been effected for a corporation to construct an electric street railway from this city to Millbury. The capital is to be $150,000, of which more than $80,000 is said to be already subscribed.

West Hartford, Conn.—An electric railway from West Hartford through Farmington to Unionville is now before the Legislature. D. H. Barney, of Farmington, can give information.

Buffalo, N. Y.—The Buffalo Railway Co. obtained control of all the street car lines in that city on Jan. 30. The Field Engineering Co. is equipping the system with an excellent electrical plant, with an aggregate capacity of 5,500 HP.

Dunkirk, N. Y.—The Dunkirk & Fredonia Ry. wishes prices on rails. Address M. M. Fenner and H. C. Lake.

Glens Falls, N. Y.—The Glens Falls, Sandy Hill & Fort Edward St. Ry. has received permission to use electricity on condition that the speed shall not exceed a limit fixed by the local authorities.

Newark, N. J.—It is reported that the South Orange Ave. horse car line will shortly be changed to an electric road. Andrew Radel can give further information.

Pittsburg, Pa.—The Suburban Electric Ry. will erect a new power-house. T. A. Noble, the Secretary of the company, is chief stockholder of the Squirrel Hill R. R., which has been reorganized as the Schenley Park & Highlands Ry. S. J. McFarren is Secretary and Manager of the new company and is now ready to receive bids for the equipment of the line.

Braddock, Pa.—A contract for a portion of the work on the Braddock & Turtle Creek Street Ry. has been let. The contracts for the power-house and machinery still remain open.

Anacostia, D. C.—Surveys for the Washington & Marlboro Electric Ry. are now nearly completed. It is reported that the railway will purchase the Marlboro turnpike.

Baltimore, Md.—The Baltimore Union Passenger Ry. has filed an application for permission to use electricity on all its lines. It is said that an electric railway operated by the overhead trolley system will be built from South Baltimore to Curtis Bay, a distance of 5½ miles. For further information address W. S. Rayner, President of the South Baltimore Co.

Wilmington, N. C.—It is reported in the local newspapers that the Wilmington Street Ry. has been sold to Philadelphia parties, who will change the line to an electric railway. For further information address E. L. Hawks.

Atlanta, Ga.—The Atlanta Street R. R. has begun extensive improvements on its lines. Steel 50-lb. rails have been distributed along the track and 50 new cars will be purchased soon. The total cost of the improvement will be about $300,000.

New Albany, Ind.—The New Albany, Highland & Suburban Ry. will begin to lay 1½ miles of track within the next 60 days for an electric freight and passenger line.

Elkhart, Ind.—The Citizens' Street Ry. has been sold to a new company, the Elkhart Electric & Railway Co., which will, it is said, extend the line and make numerous improvements. O. N. Lumbert is President and E. P. Millard Secretary of the company.

Independence, Ia.—The Electric Street Ry., controlled by C. W. Wilhams, has been granted a 25-year franchise for lines on a number of streets.

Houston, Tex.—The Houston City Street Ry. has purchased a site for the power plant.

San Francisco, Cal.—The San Francisco & San Mateo Ry. has been incorporated to build an electric road under franchises granted to B. Joost and others. The capital stock is $2,000,000.

Los Angeles, Cal.—The Consolidated Electric Ry. will, it is said, equip its lines with Westinghouse machinery.

Tacoma, Wash.—It is reported that the Point Defiance R. R. will be equipped with storage battery cars by the River & Rail Co. It is also reported that the Tacoma & Puyallup Ry., 14 miles long, will be equipped with the same system.

Seattle, Wash.—A meeting of the stockholders of the Rainier Power & Ry. Co. will be held March 16, to vote on an increase of the capital stock from $100,000 to $500,000, in order to raise funds for the extension and completion of the road and an enlargement of the electric plant. Several other companies are also contemplating improvements.

Los Angeles, Cal.—The Belt Electric R. R. is reported to have let partial contracts for 12 miles of double track.

Horse Railways.—New lines are proposed at Newport News, Va., and La Grande, Ga.

Toronto, Ont.—The time for receiving bids for the purchase of the street railway franchise has been extended to Feb. 20.

Dummy Railways.—***Carrollton, Ga.***—Adamson & Jackson want estimates on the construction and equipment of a dummy line.

Jacksonville, Fla.—The Main Street Ry. has decided to run its cars to the Sub-Tropical Exhibition by a Connelly motor car, made by the Lewis & Fowler Co., of Brooklyn, N. Y.

Santa Clara, Cal.—R. H. Quincey has applied to the Santa Clara Supervisors for a franchise for a motor road, to cost $150,000. The motor will probably be similar to that used in the Hoskins car, now operating with some success in Stockton, or an 8-HP. gas engine from the Pacific Gas Engine Co., of San Francisco.

Portland, Ore.—The Barnes Heights & Cornell Mountain Ry. has applied for a franchise to build a 5-mile motor line. In the first mile of the proposed route the steepest grade is 10%, and the greater part of the mile is at 7%. The remainder of the line is much easier, never exceeding 4%. It is proposed to use 40-lb. steel rails and double truck cars with 60-HP. engines.

New Companies.—Syracuse & Baldwinsville Ry.; capital stock, $160,000; directors, W. C. Andrews, W. A. Cauldwell, R. A. Dorman, of New York, and others. Fulton & East Clinton Street Railway & Power Co., Fulton, Ill.; capital stock, $20,000.

HIGHWAYS.

New Jersey.—Dr. Chauncey B. Ripley, of New York, addressed the State Board of Agriculture at Trenton on Jan. 28. He urged that two State roads—one from the extreme northern to the extreme southern, and the other from the eastern to the western margins of the State—should be at once constructed in the interest of the citizens of New Jersey, and especially in the interest of the farmers. The construction and care of such roads, he maintained, are within the scope of the Governor's recommendation to the Legislature; it was desirable from every point of view, and was in the interest of every citizen; and he declared that in 20 years they will compensate the State and reimburse the treasury for every dollar expended.

Alabama.—A road bill has been introduced in the Senate by Mr. Hargrove. The bill will make it obligatory upon the Commissioners' Courts of the various counties to lay apart some portion of the general revenue not to exceed a stipulated amount, or the sum may be raised by a special tax as may be preferred. Each county is to be divided into convenient road districts by the Commissioners' Court, and it is to appoint a Road Commissioner for each district, incorporated towns and cities not to be included in such districts, and such Commissioners shall have control of the overseers and supervise and direct the working of roads in their respective districts. Those liable for road duty are fixed at between the ages of 18 and 50 years.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Granville Ferry, N. S.***—It is stated that work will be soon commenced on a steel draw-bridge at this place. This bridge will be about 1,300 ft. from shore to shore at high water mark, or 800 ft. at low water. The main channel of the river is about 45 ft. deep at low water, which will be spanned by a steel truss of 400 ft. The stone piers on which this rests will be in 25 ft. water at lowest tide. The draw will be the largest of any in the Dominion, having two openings of 180 ft. width, each with 22 ft. at lowest tide. It will be nearly in the center of the river and where there is only two knots of tide at a half tide, with a counter current on the inshore side, and will admit of ocean steamers of over 3,000 tons passing up the river into French bay.

Troy, N. Y.—A bill will be introduced into the New York State Legislature authorizing the municipality to build a viaduct over the Fitchburg R. R. tracks connecting Eighth St. with Sixth Ave.

Detroit, Mich.—The City Engineer has prepared a plan for the Virginia Ave. viaduct. This plan is for a viaduct with a total length of 1,300 ft.; 720 ft. of this is to be of stone approaches, 412 ft. at the north and 308 ft. at the south end. There will be 500 ft. of iron superstructure, 220 ft. of double-truss span, and the remainder, 280 ft., of five spans of plate girders. Several other plans have been submitted. It is expected that work will begin about March 1.

Bay City, Mich.—Plans have been prepared by Henry E. Brawner for a bridge at Belinda St., 600 ft long and 21 ft. wide. Estimated cost, $80,000. The plans provide for a draw span 260 ft. long. About $30,000 have been raised.

Lansing, Mich.—Plans have been prepared for a highway bridge 200 ft. long, 30 ft. wide, two 8-ft. sidewalks, by Henry E. Brawner, C. E., Bay City, Mich. P. O'Connel is the city engineer.

West Union, W. Va.—Two steel bridges will be built across Nutter's fork. J. C. Couleman can give information.

Milwaukee, Wis.—Plans are being prepared for a viaduct across Menominee Valley, to cost about $300,000.

Ft. Worth, Tex.—A bridge will be built to replace the structure known as the Big North Side bridge. The original structure cost $30,000.

WATER-WORKS.

NEW ENGLAND.

Groveton, N. H.—The Groveton Water Co., referred to last week, have already built works.

Townsend, Vt.—Works are being talked of.

Manchester, Mass.—The following is from Samuel Knight, Chairman:

On Feb. 2 the Water Committee were instructed by a popular vote of 148 to 16 to apply for an act under which works may be constructed, provided the same is accepted by the citizens at a meeting which will probably be held in March. It is proposed to pump water from Saw Mill Brook to a stand-pipe. The works are estimated to cost $125,000. Percy M. Blake, Hyde Park, is Engineer for surveys. The population is 1,800, which is increased in summer to about 5,000.

Orange, Mass.—At a recent town meeting W. L. Grant, J. B. Reynolds and three others were appointed as a water committee to investigate and report at the next annual meeting. It is stated that the town is in favor of establishing works at an early day. Since 1875 water for domestic use has been furnished by the New Home Sewing Machine Co.

Bethel, Conn.—See our advertising columns for particulars regarding the letting of contracts for a new dam and filter bed.

New Haven, Conn.—The Legislature is to be petitioned for authority to purchase the works of the New Haven Water Co., the price to be decided upon by the Superior Court. J. B. Sargent is Mayor.

Portland, Conn.—A bill has been introduced in the Legislature authorizing the town to buy the works of the Portland Water Co.

MIDDLE.

Batavia, N. Y.—W. D. Smith, Clerk, informs us that $10,000 was voted on Jan. 28 for a pump and that D. L. Dodgson, R. S. Fargo and W. D. Sanford are the Pump Committee.

Cherry Creek, Sherman and Sinclairville, N. Y.—A company is being organized at each of these places, of which P. N. Cowan will be President and Engineer and Jessie B. Cowan, Secretary. In each case the supply will be from springs by gravity, at an estimated cost of from $30,000 to $40,000. The time of beginning construction is not stated. The population of the villages range from 1,200 to 1,500.

Niagara Falls, N. Y.—It is reported that the plant of the Niagara Falls Water-Works Co. has been purchased by the Cataract Construction Co., and will be operated by the latter in connection with their water supply for manufacturing purposes; also that the works will be extended.

Schenectady, N. Y.—A new supply, estimated to cost $125,000, has been recommended. Wells may be sunk on Van Slyck Island, in the Mohawk River, above the city.

Walden, N. Y.—Works are projected by a company.

SOUTHERN.

New Castle, Va.—The following is from P. V. Jones:

The New Castle Water Co. expect to let contracts for works about May 15. Water will be pumped from John's Creek to a reservoir. The works are estimated to cost $10,000. S. Grover is Engineer, and P. W. Scott or A. E. Humphreys can give information. Population, 500.

Asheville, N. C.—The Asheville & Victoria Water Supply Co. proposes to introduce water into South Asheville and Victoria (evidently suburbs of Asheville). S. H. Reed, M. E. Carter and others have applied to the legislature for a charter.

Columbia, S. C.—It is reported that $75,000 of bonds will be issued, new water-power pumping machinery introduced, and other improvements made.

East Rome, Ga.—The following is from O. H. McWilliams, Mayor:

A charter has been granted a company, the town has voted a tax to pay for hydrant rentals, and probably works will be built this summer. Population, 500.

Brewton, Ala.—Authority to issue $25,000 of bonds for water-works and other purposes has been asked of the legislature.

Jasper, Ala.—The Jasper Water-Works Co. has applied for a charter.

Montgomery, Ala.—A bill authorizing the city to buy or build works has been signed by the Governor.

Chattanooga, Tenn.—The National filter plant at Chattanooga will be enlarged. Its present daily capacity is about 7,000,000 galls.

Dyersburg, Tenn.—It is stated that works are being built.

Johnson City, Tenn.—Gravity works are being built by the Watauga Water Co., with A. E. Boardman Engineer and Treasurer and the Jeter & Boardman Gas & Water Association as contractors. The works will be put in operation about Oct. 1. Population, 5,000.

Harrodsburg, Ky.—Plans for works have been submitted by J. P. Herdic, Williamsport, Pa. They provide for a pump of at least 1,000 000 galls. capacity, a standpipe 110 ft. high, about 6 miles of pipe and 70 hydrants. Population, 3,200.

NORTH CENTRAL.

Canton, O.—Paul Field, Secretary, informs us that steps have been taken by the Trustees toward purchasing a pump to lift water from a gang of wells, but they have not decided what they want.

Columbus, O.—Six new boilers have been recommended, and extensions to the mains will probably be made.

Van Wert, O.—The following is from John W. Hill, Engineer, Cincinnati:

Works estimated to cost $120,0 0 are under construction by the town. Some of the contracts have been let, but proposals will again be invited for pumping machinery and station, reservoir and fire hydrants. The supply will be from a system of 6-in wells from 140 to 228 ft. deep, from which water will be pumped directly to the mains, the surplus going to a 3,000,000 gall. reservoir, with its flow line 24 ft. above the flow line of the engine pit. There will be two 1,500,000 gall. compound condensing duplex direct-acting pumps and two return tubular boilers. The pumping station will be of brick, with cut-stone trimmings. The chimney will be octagonal, 4 ft. in diameter by 70 ft. high.

West Bay City, Mich.—The following is from J. H. Blomshield:

Experimental wells are being sunk by the Cook Well Co., St. Louis, Mo., for a new supply.

Kalamazoo, Mich.—It is proposed to sink another well adjacent to the bed of springs south of the Kalamazoo & South Haven R. R. City Engineer Frank C. Balch has been directed to make the necessary surveys with a view of connecting the proposed well with the present system.

NORTHWESTERN.

Toledo, Ia.—The construction of a small plant will soon be started. A 1,000 000-gall. pump will lift water to a 30,000-gall. tower. The supply will be from a deep well and there will be about two miles of pipe and 24 hydrants, G. C. Morgan, Chicago, Ill., is Engineer and Contractor.

New London, Minn.—Works are being built, it is stated.

Willmore, Minn.—H. J. Ramsett, Recorder, has sent the following:

A bill authorizing the issuance of $20,000 of bonds by the village is before the legislature. Probably a popular vote on the issuance of the bonds will be taken about the middle of the month.

Kearney, Neb.—It is reported that works will be built here by H. D. Watson and H. H. Martin, of the Miller Land Co The City Water Co. built works in 1887.

SOUTHWESTERN.

Brookfield, Mo.—D. F. Howard, Clerk, informs us that the water-works proposition has been voted down.

Palmyra, Mo.—W. H. Allen, Engineer, Clinton, Mo., informs us that the works of the Palmyra Light & Water Co. were put in operation Feb. 1. Water is pumped to a stand-pipe, and there are 4 miles of mains.

Cisco, Tex.—The following is from a resident:

The Cisco Water Co. will receive bids for works until Feb. 15; estimated cost, $20,000. J. F. Patterson is President and J. H. Holcomb Manager. Population, about 1,500.

Denton, Tex.—It is stated that the Denton Water Light & Power Co. has been organized by W. J. Williams, Dallas, with J. Rourke as President. The works are estimated to cost $50,000.

PACIFIC.

Hoquiam, Wash.—O. P. Burrows informs us that the council will probably take some action regarding water works soon. As we have previously stated, the North western Lumber Co. has a small system of water-works in operation. This, the company states, it wishes to sell to the city or a company. The works were built in 1882. Their supply is from several small streams collected in a reservoir at an elevation of 107 ft. Pumps are used in connection with the works. They have three miles of pipe and 10 hydrants, and the works have cost $10,000. A. M. Simpson is President of the company.

Grant's Pass, Ore.—W. Knox, Contractor, Haywards, Cal., has sent the following:

The water-works of the Grant's Pass Water, Light & Power Co. were put in operation Feb. 1. Water is pumped by water-power from Rogue River to a reservoir. There are about 7 miles of mains.

La Grande, Ore.—It is reported that the Council has accepted a proposition from J. K. Romig and others to build works, and that Denver people are interested. Works are to be commenced immediately after the contract is closed, and 5 miles of mains are to be laid within a year. Estimated cost, $60,000. The La Grande Water Co. built works here in 1887.

Portland, Ore.—The Legislature has passed a bill authorizing the issuance of water extension bonds. It is stated that a gravity supply will be introduced from Bull Run.

CANADA.

Cote St. Paul, P. Q.—H. F. Moulden, Village Secretary, informs us that a by-law has been approved by the citizens granting a franchise to the Montreal Island Water & Electric Co. Work is to be started in the spring. The supply will be from the rapids of the Ottawa River in the parish of Sault au Recollet, and the pipe will be of cast-iron.

Saint Lambert, P. Q.—D. O. Davies informs us that an effort is being made to secure water-works and drainage.

Barrie, Ont.—Henry Bird informs us that works are being built by Hinds & Bond, Watertown, N. Y. The supply will be from artesian wells and Lake Simcoe, and will be pumped to a stand-pipe.

ARTESIAN WELLS.

Opelousas, La.—An artesian well is projected by the town.

Groton, S. Dak.—Messrs. Burnham, Adams, Griggs and Anderson have bought machinery and are sinking artesian wells on their farms. Water with 140 lbs. pressure, it is stated, has been struck on Mr. Burnham's land.

Dallas, Tex.—A well has been sunk by J. J. Brick.

McGregor, Tex.—The McGregor Artesian Well Co. has ordered machinery to sink a well.

Waco, Tex.—A contract for a well has been awarded to Lew Damon.

IRRIGATION.

Choteau, Mont.—Surveys are to be made by the Eureka Reservoir & Navigation Co. looking to the development of water for about 40,000 acres of land north of Choteau, between Seton and Muddy rivers. It is proposed to let contracts and begin the construction of ditches as soon as the surveys are made. Z. T. Burton and J. P. Bouscaren, of Helena, the latter an engineer, are the promoters, together with T. W. Pellum, New York City, lately interested.

National City, Cal.—E. S. Babcock is building a reservoir for irrigating purposes on Otay Creek, 11 miles from this city.

Anaheim, Cal.—It is reported that the Anaheim Union Water Co. will sell its works and rights to the Anaheim Irrigation District for $160,000 of the latter's bonds. There are 32,500 acres in the district. It is stated that $600,000 of bonds have been authorized, and that work will be done at once.

SEWERAGE AND MUNICIPAL.

Sewers.—***Buffalo, N. Y.***—The Committee on Sewers has reported in favor of the Albany St. trunk sewer.

Peoria, Ill.—The ordinance providing for the construction of the Main St. sewer, and for a special tax for this purpose, has been declared illegal by the courts.

Cicero, Ill.—A sewer is proposed to be built by Chicago, on Robinson St., to connect with a sewer to be built in Cicero to Mud Lake.

Atlanta, Ga.—It is proposed to extend the Lloyd St. and Butler St. sewers at a cost of $40,000 and $50,000 respectively.

East Portland, Ore.—Mr. Rudolph Hering, of New York, is preparing the plans for the city's system of sewerage, and has presented a report on the assessment question, in which he recommends that the system be paid for by assessing the abutting properties at a certain rate per foot of frontage.

Hanford, Cal.—The Hanford Drainage & Sewerage Co. has been incorporated by Nathan Weisbaum, John H. Melone and Frank L. Dodge.

Brantford, Ont.—Mr. Willis Chipman, City Engineer, states that it is expected to construct 12 miles of sewer this year at a cost of $100,000.

Barrie, Ont.—One mile of sanitary sewer is now under contract. Mr. Willis Chipman is the engineer.

Streets.—***Omaha, Neb.***—The city has paved streets as follows: Cedar and cypress blocks, 24.96 miles; sandstone and granite blocks, 17.45 miles; asphalt, 15.74 miles; brick, 3.05 miles.

Lighting.—***Bloomfield, N. J.***—The Township Committee has accepted the proposition of the Montclair Gas & Water Co. to light the streets with gas until midnight at $14.55 per lamp.

Cincinnati, O.—The Committee on Light has received the following bids per year for gasoline lighting for 5 years: F. Fogerty, $19.85 all night, $16.75 moonlight table, $1.90 for iron post, $1.80 for wooden post. F. Switzer, $17.60, $16, $2, $1.80. Sun Vapor Street Light Co., of Canton, O., $21.50, $17.50, $2, $1.75. T. W. Martin, $17.20, $14, $1.85, $1.25.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following cities: Laconia, N. H., address the Gilford Hosiery Mill; Danville, Va., address the Electric Light Committee of the City Council; Leslie, Mich.; Warsaw, N. Y.; Harlan, Ia.; Eastlake, Ala., address the Electric Light Co.; Culberson, N. C., address the Nottla Consolidated Iron, Marble and Talc Co.; Springfield, Utah; Baltimore, Md., address the International District Telegraph & Construction Co.; Colorado and Palestine, Tex.

Saratoga, N. Y.—The Saratoga Gas & Electric Light Co. has bought out the Consumers' Gas & Electric Light Co., and will, it is said, build a new electric light plant.

Chartiers, Pa.—The Chartiers Electric Light Co. will probably erect a plant in this borough. The directors are: D. Healy, R. McMunn, C. Durham and J. Lee.

Washington, D. C.—Capt. Lusk has filed a report on street lighting in which he states that the United States Electric Lighting Co. will furnish 2,000 c. p. lights at $219 per year on a single year contract, $197.10 and $186.15 on 5 and 10-year contracts. The Electric Heat & Power Co. does not consider an annual contract, but will furnish 2,000 c. p. lights for 5 or 10 years at $164.25 per annum on an all-night schedule. The same company will furnish 25-c. p. incandescent lamps at $15 per year of 2,000 hours. Both companies will use underground conduits.

Richmond, Va.—The City Council has voted $75,000 for purchasing an electric light plant.

Tampa, Fla.—The Florida Electric Co. has a 3-year contract for furnishing 2,000-c. p. arc lights at $11 per month and 32-c. p. incandescent lamps at $2 per month.

Clarksdale, Miss.—The City Council wishes bids for erecting water-works and an electric light plant.

Del Rio, Tex.—C. L. Woods wishes prices for an electric light plant.

Arcola, Ill.—It is reported that the city will erect a municipal electric lighting plant. Further information may be obtained from S. R. Coan.

Columbus, O.—Bids are wanted for furnishing a municipal lighting plant.

Salem, Ind.—The City Council has granted the Salem Electric Light & Ice Co. an exclusive franchise for 10 years for electric lighting, and has ordered 10 lights at $75 per lamp annually. A $15,000 plant will be erected.

San Diego, Cal.—Bids will be opened Feb. 19 for lighting the city with 11 masts carrying 6 lights of 2,000 c. p. each, and 22 single 2,000-c. p. lights.

Redwood City, Cal.—The City Trustees desire bids for furnishing the following machinery and supplies: One 12 × 12 automatic cut-off engine complete; a horizontal tubular boiler 64 × 16; a dynamo for supplying 30 to 35 arc lights of 1,200 c. p. each; a dynamo for supplying 300 incandescent lamps of 16 c. p.; wire, poles, etc.

Electric Plant for Lightship.—***Tompkinsville, N. Y.***—The following bids for supplying a complete lighting plant for a lightship were opened Feb. 2:

	Steam and Elec. Plant.	Installation and Wiring.	Total.
Thomson-Houston Electric Co.....	$2,080	$185	$2,265
U. S. Electric Lighting Co....	2,570	615	3,185
Edison General Co.....	2,377	215	2,592

New Companies.—Morrisonville, Ill., Electric Light Co.; capital stock, $4,000; incorporators, H. C. Bohn, J. W. Campbell, E. D. Green, A. E. Gowin. Chicago, Ill., Insulated Wire Co.; capital stock, $50,000; incorporators, W. G. Adams, H. W. Plantz, P. Brown. North American Electric Co., Chicago, Ill.; capital stock, $100,000; incorporators, J. H. Donnelly, F. J. Lally, M. H. Beach. Salem, Ind., Electric Light & Ice Co.; capital stock, $15,000; E. Heim, Secretary. Day Electrical Construction Co., Chicago, Ill.; capital stock, $1,000,000; incorporators, E. F. Getchell, L. D. Thoman, N. L. Ross. Eckert Electric Mfg. Co., Newark, N. J.; capital stock, $500,000; incorporators, W. H. Eckert, of New York; J. M. and L. Seymour, of East Orange. Chicago, Ill., Electric Motor Co.; capital stock, $250,000; incorporators, B. D. Southard, J. H. Dean, E. A. Manship.

CONTRACTING.

Masonry.—Proposals for furnishing materials and building the masonry of a lock at the St. Mary's Falls canal, Michigan, were opened Jan. 27 by Col. O. M. Poe, U. S. Engineer Office, Detroit, Mich. The quantities are about 22,000 bbls. of Portland cement, 75,000 bbls. of natural cement, 20,000 cu. yds. of cut stone, laying 20,000 cu. yds. of cut stone in lock wall, 55,000 cu. yds. of backing stone, laying 59,000 cu. yds. of backing stone in lock wall, laying 5,000 cu. yds. of concrete for foundations of lock, filling 70,000 cu. yds. of earth behind wall. All prices in the following table are per cubic yard. The locations of the quarries are as follows: *a*, Marblehead, O.: *b*, Mankato, Minn.; *c*, Kelly Island, O.; *d*, Stinesville, Ind.; *e*, Bedford, Ind.; *f*, Drummond Island, Mich.; *g*, Cleveland, O.; *h*, Lemont, Ill.; *i*, Joliet, Ill.

PROPOSALS OPEN.

Canal Wall.—*Whitehall, N. Y.*—Raising and rebuilding 483 ft. of wall on berme side of Champlain canal. Edward Hannan, Superintendent of Public Works, Albany, N. Y. Feb. 10.

Water Plant.—*Medical Lake, Wash.*—For hospital; 30 HP. boiler, 14,000 ft. of 6-in. pipe for 250 lb. pressure, reservoir 75 × 90 × 10 ft., pipe laying, pumping station, etc. Board of Trustees of Eastern Washington Hospital for the Insane. Feb. 10.

Steamer, Filling, Timber.—*New York, N. Y.*—Steel propeller; filling behind bulkheads. Feb. 11. Sawed yellow pine timber. Feb. 18. Docks Department, Pier A, North River.

Sewers.—*Waltham, Mass.*—About 2 miles of brick and 33 miles of pipe sewers; also furnishing 3,000,000 hard burned brick, 625 cast-iron manhole covers, 7,500 bbls. of Rosedale cement, 500 bbls. Portland cement. Chief Engineer, E. W. Bowditch. Board of Sewer Commissioners. Feb. 11.

Dike.—*Smithland, Ky.*—Furnishing materials and constructing dike. Lt.-Col. J. W. Barlow, U. S. Engineer Office, Nashville, Tenn. Feb 27.

Jetty.—Timber jetty in Trinity River. Major C. J. Allen, U. S. Engineer Office, Galveston, Tex. Feb. 25.

Sand Fences.—*Duluth, Minn.*—Building about 1,216 lin. ft. of sand fences on Minnesota Point. Lieut. G. D. Fitch, U. S. Engineer Office. Feb. 27.

Masonry, Etc.—*Cincinnati, O.*—For gasholder tank 157 ft. diameter; 9,000 cu. yds. excavation, 5,000 cu. yds. back filling, 800 cu yds. concrete, 1,000 cu. yds. limestone, 700 cu. yds. sand, 1,000 cu. ft. stone coping, 825,000 front and paving bricks, and laying same. Cincinnati Gas Light & Coke Co. Feb. 14.

Bidders.	Portland cement.	Natural cement.	Cut stone. Kind.		Laying cut stone.	Backing stone. Kind.		Laying backing stone.	Laying concrete.	Earth filling.	Total.
	$	$			$		$				
Hughes Bros. & Bangs, Syracuse, N. Y..	3.00	1.30	*a* Limestone.	26 00	2.50	*f* Limestone.	6.00	2.50	4.50	.50	1,268,500
Collins, Farwell & Adams, Detroit, Mich.	4.35	1.62	*a* "	30.37	2.43	*f* "	2.85	2.55	10.50	.90	1,294,250
Zimmerman, Truax & Co., Duluth, Mich.	3.35	1.30	*b* Dolomite...	22.00	5.00	*f* "	5.00	4.40	5.75	.48	1,308,150
" " "	3.35	1.30	*b* "	22.00	5.00	*b* Dolomite...	12.50	4.40	5.75	.48	1,720,650
" " "	3.35	1.30	*b* "	22.00	5.00	*g* Sandstone..	12.00	4.40	5.75	.48	1,693,150
" " "	3.35	1.30	*c* Limestone..	27.00	5.00	*f* Limestone.	5.00	4.40	5.75	.48	1,408,150
" " "	3.35	1.30	*c* "	27.00	5.00	*b* Dolomite...	12.50	4.40	5.75	.48	1,820,650
" " "	3.35	1.30	*c* "	27.00	5.00	*g* Sandstone..	12.00	4.40	5.75	.48	1,793,150
Sou'e & Raynor, Syracuse, N. Y.....	3.25	1.40	*a*, *e* "	30.00	4.00	*f* Limestone.	4.70	3.00	4.50	.50	1,349,500
Noble, Griffin & Davock, Detroit, Mich..	3.25	1.20	*a* "	27.00	3.00	*f* "	7.60	3.24	6.00	.98	1,469,260
" " "	3.25	1.20	*a* "	27.00	3.00	*a* "	12.00	3.24	6.00	.98	1,711,260
Carkin, Stickney & Cram, East Saginaw, Mich.....	3.50	3.00	*a* "	23 00	2.00	*f* "	6.00	4.88	5.00	.75	1,497,420
Angus & Glndele, Chicago, Ill	3.25	1.15	*d* Dolomite...	23.95	3.55	*h* "	9.40	3.75	4.95	.45	1,502,250
John Hickler & Son, Buffalo, N. Y.....	3.40	1.25	*b* "	27.00	4.83	*f* "	8.00	4.00	6.00	.75	1,563,650
" "	3.40	1.25	*a* Limestone..	32.00	4.83	*f* "	8.00	4.00	6.00	.75	1,663,650
Connolly & Neelow, St. Catharines, Ont..	3.65	2.00	*a*, *c* "	24.50	2.50	*a*, *c* "	10.65	2.00	4.00	1.00	1,564,050
Henry A. Sanger, Joliet, Ill.....	3.30	1.10	*e* "	30.80	2.70	*f* "	9.57	2.70	10.00	.50	1,595,750
" "	3.30	1.10	*e* "	30.80	2.70	*i* "	11.00	2.70	10.00	.50	1,674,400

* Or Lake Superior sandstone.

Excavation.—The following proposals for excavating at Hay Lake Channel, St. Mary's River, Mich., were opened Jan. 26 by Col. O. M. Poe, U. S. Engineer Office Detroit, Mich. Sec. 1: John Hickler & Son, Buffalo, N.Y., $1.20 per cu. yd.; C. F. & H. T. Dunbar, Buffalo, N. Y., $1.27; Carkin, Stickney & Cram, East Saginaw, Mich., $1.47½; L. P. & J. A. Smith, Cleveland, O., $1.50. Sec. 2: Dunbar & Sullivan, Buffalo, N. Y., 57 cts.; Carkin, Stickney & Cram, 68½ cts.; John Hickler & Son, 70 cts.; L. P & J. A. Smith, 74.8 cts. Sec. 3: Carkin, Stickney & Cram, 14¾ cts.; L. P. & J. A. Smith, 16.9 cts. Sec. 4: Carkin, Stickney & Cram, 13 cts.; L. P. & J. A. Smith, 17 cts. Sec. 5: C. F. & H. T. Dunbar, 14 cts.; James Rooney, Toledo, O., 14½ cts.; Carkin, Stickney & Cram, 14¾ cts.; White & Finch, Grand Haven, Mich., 15.9 cts.; L. P. & J. A. Smith, 16 cts.; Luther E. Allen, Charlevoix, Mich., 46⅝ cts. Sec. 6: Carkin, Stickney & Cram, 14¾ cts.; L. P. & J. A. Smith, 19.9 cts.; L. E. Allen, 46⅝ cts.

Street Work.—*Amsterdam, N. Y.*—Mr. F. E. Crane, City Engineer informs us that the contract for about 20,000 yds. of paving on E. Main St. has been awarded to the Warren-Scharf Asphalt Paving Co., of New York, at $2.80 per sq. yd. The bid on granite blocks was $4, and on sandstone $3.75 per sq. yd.

Chicopee, Mass.—The cost of new concrete sidewalks is about 45 cts. per sq. yd., and 24 cts. for recoating.

Settling Basins.—*St. Louis, Mo.*—The following proposals for four basins 670 by 400 ft. have been received by the Board of Public Improvements: Heman Construction Co., $690,125; McCormick Construction Co., $709,882; Allen & Vieths, $720,524; Fruin-Bambrick Construction Co., $724,050; Smith & Minahan, $727,795; Wm. McCully, $749,805; Black & Davis, $753,715; John Hill, $753,910; Scott, Lantry & Sons, $777,843; T. J. Prosser & Co., $799,680; Laine & Mulcahy, $842,316.

Pipe.—Oakland, Cal. The following prices were bid by Strum & Leith, for galvanized iron pipe: 24, 27 and 32 cts. per ft. for 1¼, 1½ and 2-in. pipe; stand-pipes, 45 cts.; valves, 95 cts.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., are building 16 engines for the Lehigh Valley and 6 for the Buffalo, Rochester & Pittsburg. The Schenectady Locomotive Works, of Schenectady, N. Y., are building 4 freight engines for the Fitchburg. The Rhode Island Locomotive Works, of Providence, R.I., are building 3 engines for the New York, Providence & Boston. The Dickson Mfg. Co., of Scranton, Pa., is building 14 mogul engines for the Delaware & Hudson. The Kinderhook & Hudson has ordered a new engine. The Cleveland & Canton has ordered 2 ten-wheel freight engines weighing 56 tons, 2 eight-wheel passenger engines weighing 40 tons, a freight engine weighing 40 tons for steep grades, and 2 switching engines.

Cars.—The Gilbert Car Mfg. Co., of Troy, N. Y., has built 5 electric vestibuled street cars for the Buffalo St. Ry. Co., of Buffalo, N. Y.; they are 34 ft. long, and have a seating capacity for 40 passengers. The body weighs about 3,000 lbs., and is carried on 2 four-wheel trucks weighing about 2,500 lbs. each. The platforms are inclosed, forming the "vestibules," and have doors opening onto the side steps. These vestibuled cars are coming into extensive use on electric railways. The company has also built 4 electric cars for the Rochester St. Ry. Co., of Rochester, N. Y. The Pullman Palace Car Co. has built 5 sleeping cars for the Grand Trunk to run between Chicago and New England points. The Lehigh Valley has 2,000 freight cars under contract. The Northern Car Co., of Robbinsdale, Minn., proposes to enlarge its works and increase its capacity. President, A. P. Jones; Secretary, Geo. P. Stearns, Minneapolis. The Madison Car Co. is building works at Madison, Ill., which will have a daily capacity of 30 box cars.

The Thomson Meter Co. has a contract to introduce its meters into Milwaukee, Wis.

The Berlin Iron Bridge Co., of East Berlin, Conn., has shipped 3 bridges to Duval Co., Tex., and 4 to San Antonio, Tex.; the latter have iron buckle plate floors and concrete surfaces, and are the first of their kind in Texas. The company is building one of its patent parabolic truss bridges for the new Croton aqueduct at Sodom dam.

The Smith Bridge Co., of Toledo, O., has completed a bridge at Chattanooga, Tenn., having 3 spans of 320 ft. and 3 of 210 ft., roadway 27 ft. wide with 2 sidewalks 6 ft. wide. Mr. Edwin Thacher was the chief engineer. The company has a contract for a bridge at Spokane, Wash., and another at Zanesville, O. The plans for the latter were prepared by Mr. Connar, County Engineer. Mr. C. L. Gates is engineer of the company.

Pipe Tapping Machine.—The Cleveland, O., Water Department has purchased the right to use the Anthony P. Smith tapping machine from the Galvin Brass & Iron Works, of Detroit, Mich., the Western agents for the machine, which is manufactured at Newark, N. J.

The Galvin Brass & Iron Works, of Detroit, Mich., are busy in all departments. Plans are being prepared for new buildings, machinery, etc., to double the present capacity of the works.

The Midway Iron Co., of Roanoke, Va., has put up a new shop, 70 × 160 ft., for the manufacture of railway spikes, rails, etc.

The Q. & C. Co. is the new name of an old organization that has made itself very well known to the railway trade in this country as the Dunham Manufacturing Co. The new officers are: President, Mr. W. L. Findley; Treasurer, Mr. C. F. Quincy; Secretary, Mr. Arthur Crandall. The company continues its offices in Chicago, New York, and Montreal, and deals in the Q. & C. trolley door, Q. & C. brake adjustor, Servis tie plate, Dunham car-door, globe ventilator, Davies spike, etc. Railway interests will please note.

The Rensselaer Mfg. Co., of Lansingburgh, N.Y., owing to the increase in its valve business and the necessity for more room, has sold its entire scale business to "Jones of Binghamton," Binghamton, N. Y. The Rensselaer Manufacturing Co. will devote the entire capacity of its new works to the manufacture of water gates and valves exclusively. The business of this firm was established 37 years ago.

Car Heating.—The Consolidated Car Heating Co. has furnished equipment for 12 private cars, principally for officers of different railways. The Delaware & Hudson Canal Co. has changed its Belt line train, running between Albany and Troy, from direct steam to the Commingler storage system, with automatic temperature regulator, using the same piping. The regulator is said to have kept these cars at 70° F., with a maximum variation of 2° either way, for several weeks during which the outside temperature varied between 0° and 60°.

New Companies.—Adamantine Brick & Paving Co., of Charleston, W. Va., to operate the street paving patents of M. Levi; incorporators, Geo. Fleming, R. Herdon and M. Levi. Akron Electrical Mfg. Co., of Akron, O.; incorporators, W. D. Chapman, F. A. Wilcox and W. B. Gamble; capital stock, $100,000. Jones Positive Nut Lock Co., of Chicago, Ill.; incorporators, Thomas D. Jones, Chas. D. Anderson; capital stock, $100,000. Lozier-Yost Seamless Tube Co., of Shelby, O.; President, D. L. Cockley; Secretary, B. J. Williams; Manager, J. L. Yost, of Toledo; capital stock, $100,000.

Metal Market Prices.—*Rails.*—New York: $30; old rails, $22 to $22.50 for iron and $18 for steel. Pittsburg: $26.50 to $27; old rails, $21.50 to $25.50 for iron, and $16 to $17 for steel. Chicago: $31 to $32; old rails, $22.75 to $23 for iron, and $14 to $18.50 for steel.

Foundry Pig Iron.—New York: $15 75 to $17.50. Pittsburg: $14.50 to $16. Chicago: $14.50 to $16.

Track Materials.—New York: steel angle bars, $1.75 to $1.90; spikes, $1.95 to $2; track bolts, 2.75 to 3 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron, 2 to 2.1 cts. for steel; iron or steel spikes, 2.1 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.95 cts. for iron and 1.85 to 1.95 cts. for steel; spikes, 2 to 2.15 cts.; track bolts, 2.8 to 3 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.35 to 4.40 cts. Chicago, 4.35 cts. St. Louis, 4.30 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.1 to 2.25 cts.; steel plates, 2.1 to 2.3 for tank, 2.4 to 2.6 cts. for shell, 2.6 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.15 to 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.25 cts.; sheared steel bridge plates, 2.40 to 2.45 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.8 to 2.9 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.